An Economic Analysis of

Uniform Capitalization Of Inventory Costs

Under §263A of the

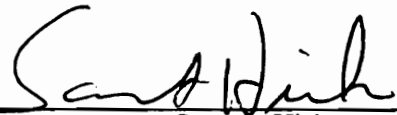Internal Revenue Code of 1986

by

J. Kent Poff

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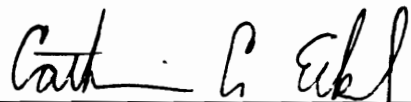
in

Accounting

APPROVED:

W. Eugene Seago, Chairman

Sam A. Hicks

Frederick M. Richardson

Catherine C. Eckel

Richard S. Steinberg

July 24, 1991

Blacksburg, Virginia

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(ABSTRACT)

Section 263A was added to the Internal Revenue Code by the Tax Reform Act of 1986. This code section applies inventory capitalization rules more uniformly across many industries and strictly increases the cost charged to inventory for tax purposes by increasing the number of cost allocations required [Seago, 1987]. The Treasury thought the changes would increase the economic efficiency of the tax system. These changes, called uniform capitalization, are analyzed by a mathematical model in this dissertation. The results reverse the conventional wisdom of the Treasury and show that the changes lead to less, not more efficient behavior and, under some reasonable assumptions, this inefficiency leads to decreases in inventory holding and production.

This dissertation contains the development of a mathematical model of uniform capitalization, performs an economic analysis of the model, and advances the conclusion that uniform capitalization causes productively inefficient behavior. The provisions of §263A that required more costs to be allocated and more industries to be covered created the inefficiency. The results show that the rules are uniform, but uniformly bad, because productive efficiency is decreased. The uniformity of the system is not the problem. The increased number of cost allocations required is the problem with §263A. Uniform capitalization has no affect on allocative efficiency because it changes the tax treatment of input, not outputs.

This dissertation also contains the development of a mathematical model of firm output and inventory holding decisions and advances the conclusion that under LIFO inventory and some reasonable cost assumptions, production and inventory holding decrease because the inefficient tax

act increases production costs. The mathematical results are consistent with the intuition developed.

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1.0 INTRODUCTION

Policy makers try to design tax policies that minimize harmful economic effects. These effects include decreases in economic efficiency which increase production cost and changes in tax burden which affect distributional equity. Based upon the intuitive analysis presented, Treasury II [The White House, p. 202] proposed changes that were thought to increase economic efficiency and equity of the tax system. These changes, called uniform capitalization in Treasury II, are analyzed using a mathematical model in this research. The results of this research reverse the conventional wisdom of Treasury II and Evans [1989]. The new results are consistent with Seago [1987] and show that the changes lead to less efficient, not more efficient behavior and this inefficiency leads to decreases in output. Chapter 1.3.1 shows that the equity arguments of Treasury II are contained in the efficiency arguments.

Uniform capitalization was implemented when §263A was added to the Internal Revenue Code by the Tax Reform Act of 1986. This code section applies inventory capitalization rules more uniformly, but not totally uniformly, across many industries and strictly increases the cost charged to inventory for tax purposes by increasing the number of cost allocations required [Seago, 1987]. Inventory capitalization refers to the amount of cost that is charged to the asset inventory and is not deducted for tax purposes. When the asset is sold, the cost is deducted for tax purposes. Costs that are capitalized in inventory are called

product costs. Costs that are charged to expense in the time period they are incurred are called period costs.

The effect of §263A is that some period costs of production and holding under §471 are reclassified to product costs under §263A and therefore the tax deduction for these additional items is deferred to the extent firms hold a given quantity of inventory. The deferral of the deduction increases the after-tax cost of production and holding by increasing the amount of tax currently paid. Increasing the amount of tax currently paid decreases the effective tax rate on the deduction for production and holding because the deduction is delayed to a future period. If firms do not hold inventory at year end, no capitalization is required, and no deferral occurs.

Section 263A imposes four kinds of economic costs onto firms. First, chapters 1.1.2 and 1.2 explain that §263A requires different capitalization rules for various types of inputs. The difference in tax capitalization results in different effective tax rates for different types of inputs. The difference in effective tax rates causes firms to use the inputs inefficiently because of tax-induced distortions, resulting in higher production costs. Second, 1.0 explains that the effective tax rate on the deduction for production and inventory holding decreases because the deduction for more production and holding cost retained in inventory is deferred. This results in a higher present value of tax payments over the life of the firm. Third, firms respond to the lower effective tax rate on the deduction for production and holding costs by changing the quantity of goods produced and inventory held. Chapter 1.1.2 explains how the change in quantities may increase overall production and holding costs per unit because of increasing marginal costs of these items. Fourth, §263A imposes additional compliance costs on firms. The effect of compliance costs is not explicitly modeled in this research.[1]

The purpose of this research is to analyze the impact of §263A on the economic behavior of profit-maximizing firms.[2] The impact of the inventory provisions of the tax code

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[1] See Halperin [1979] for a discussion of this issue.

[2] Behavior in this context refers to the rational choice of profit-maximizing firms. Taxes may also have psychological or sociological effects, but these are not addressed in this research.

on firm behavior are explained first through intuition. Then mathematical models of the tax code are developed. These models are then analyzed using standard economics to determine the effects of the tax code on firm behavior.

The essential implication from this research is that tax accounting rules matter because they have economic consequences. That is, tax accounting rules determine how costs are measured for tax purposes and thus how much tax is paid. This means that tax accounting rules determine real economic costs that impact firm input and output decisions. Tax accounting rules are not just labeling issues. Costs for tax purposes should not be charged based on ad hoc judgements concerning which costs benefit which activities, but should be charged based on real economic costs, if one wishes to maximize economic efficiency.

1.1 *Motivation*

1.1.1 Analysis of Why Firms Hold Inventory

Taxes affect economic behavior of profit-maximizing firms. If one is to understand the behavioral effects of changing tax valuation rules for inventory, one must understand why firms hold inventory. Firms hold inventory to minimize the total economic costs of production and holding over a number of time periods.[3] Inventory may be held by a multi-period firm for a number of specific reasons. These reasons may include (among others) the smoothing of production costs when demand fluctuates deterministically, hedging against the risk of stocking out when demand fluctuates stocastically, one-time production runs when

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[3] Just in time inventory systems are designed to minimize total production and holding costs [O'Boyle, 1990]. This research does not explicitly consider just in time inventory, but more generally examines how production and inventory holding change because of tax changes, given that firms minimize total cost.

models change, and the tax cost of liquidating LIFO inventory layers [Cohen and Halperin, 1980]. The amount of inventory that is held depends upon the trade-off of production costs, holding costs, costs of stocking out, and costs of LIFO liquidations [Levy, 1974, Sunder, 1976a and 1976b and Cohen and Pekelman, 1978 and 1979]. For simplicity, it is assumed in this research that there are no stockouts, one-time production runs, or LIFO liquidation costs. As a result, the focus is on the smoothing of production costs when demand fluctuates deterministically.

Firms have the choice of producing some (or no) output in each of several periods, incurring holding costs, and selling the output over the periods involved, or producing output and selling that same output in a given period and incurring no holding costs. As firms approach practical production capacity, marginal production costs start to increase. When there are increasing marginal production costs and very low holding costs, one would expect to see relatively equal production each period because smoothed production is cheaper than uneven production. For example, assume that a firm expects to sell fifty units in period one and sixty units in period two. If the marginal production cost of unit fifty is $20, but the marginal production cost of unit sixty is $30, it may be cheaper to produce fifty-five units each period and hold five units between the periods to avoid some of the increasing marginal production cost. As holding costs increase relative to production costs, inventory holding will decrease and more production will be matched to the period sales occur. In the preceding example, if holding costs are $15 per unit, firms will incur the additional marginal production cost of $10 to avoid the marginal holding cost of $15. As a result of the relationships between marginal production and holding costs, firms subject to deterministically fluctuating demand and increasing positive marginal production and holding costs may find production patterns that result in inventory holding, and the corresponding holding costs result in higher levels of profit than producing and selling all output in the same period with no holding costs.

1.1.2   Economic Effects On Production and Inventory Holding Of §263A

The basic argument in this chapter is that §263A increases present and future production and inventory holding costs to the extent firms hold a given quantity of inventory. Because the costs of production and holding have increased, firms will choose a different combination of production and inventory holding than they chose prior to §263A. If §263A results in more inefficient behavior than §471, the new combination of production and inventory, given the new tax act, must be more expensive than the old combination of production and inventory were under the old tax act, or else the new combination would have been chosen previously. The increase in production and holding costs also appears to decrease total production and holding, but the direction of the change in inventory and production each year is ambiguous, given that production and inventory holding one period is a substitute for production in a future period. This ambiguity is explained later in this chapter.

Section 471 requires that some, but not all, input costs be capitalized in inventory for tax purposes. Section 263A increases the number of costs that must be capitalized. Capitalizing a particular cost in inventory defers that deduction for tax purposes and increases the after-tax cost of that input. Increasing the after-tax cost of some, but not all, inputs causes firms to substitute one input for another in an attempt to reduce the after-tax cost of production and inventory holding. For example, firms have the choice of producing high-quality outputs with a small amount of advertising, or producing lower-quality outputs with more advertising. Firms choose the optimal amount of advertising and quality based on the economic benefits and costs of each. Quality control was not capitalized under §471, but is capitalized under §263A. Advertising was neither capitalized under §471 nor under §263A. Capitalizing the cost of quality control under §263A increases the after-tax cost of this input relative to advertising, causing firms to shift some resources from quality control to advertising. If §263A results in more inefficient behavior than §471, this shift in resources is inefficient

because the tax code induces firms to use inputs in combinations they would not have otherwise used. Any new input combination must be more expensive or else the profit maximizing firms would have used this combination previously. Chapter 1.2 explains how various categories of input costs are accounted for under §471 and §263A. See chapter 1.3.3 and 4 for more discussion of efficiency.

The decrease in the effective tax rate on the deduction for some inputs increases the overall after-tax cost of these items and is inefficient because total production and holding costs are increased. The increase in production and holding costs results in an increase in price and a decrease in quantity demanded over the life of the firm. It is not clear, however, that both production and inventory holding decrease each period when the effective tax rate on the deduction for each decreases. For instance, if production cost increases each of two periods because of a change in the tax code, production each period declines because of the cost increases. If the production cost increases more in the present than in the future, firms shift some of the remaining production from the present to the future, resulting in an even greater decline in production in the present and, as a result, lower levels of inventory in the present. Although total production over the life of the firm decreases, the effect on future production is ambiguous because there are two offsetting effects. Future production decreases because production cost increases, but increases because future production is relatively less expensive than present production. The following paragraph demonstrates that an increase in holding cost is equivalent to an increase in future production cost and decreases or reverses the shift of production from period one to period two and decreases or reverses the reduction in inventory held.

For example, assume that a firm expects to sell fifty units in period one and sixty units in period two. If the period one marginal production cost of unit fifty is $20, holding cost is $6 per unit held, and the period two marginal production cost of unit sixty is $30, it is rational for the firm to hold some inventory to avoid some of the increasing marginal production cost. After the imposition of §263A, if the period one marginal production cost of unit fifty increases to $25, holding cost increases to $8 per unit held, and the period two marginal pro-

duction cost of unit sixty increases to $31, it is rational for firms to hold less inventory and shift some production from period one to period two to avoid the large cost increases in period one. The decline in inventory and the shift in production from period one to period two occurs because the increase in period one production cost is greater than the sum of the increases in holding cost and period two production cost. This relationship shows that an increase in holding cost has the same result as an increase in period two production cost.

Conversely, if production cost increases more in the future than in the present because of a change in the tax code, firms shift some of the remaining production from the future to the present, resulting in an even greater decline in future production and, as a result, higher levels of inventory. Although total production over the life of the firm decreases, the effect on present production is ambiguous because there are two offsetting effects. Present production decreases because production cost increases, but increases because present production is relatively less expensive than future production. An increase in holding cost has the same result as an increase in future production cost and increases the shift of production from the future to the present and further increases the inventory.

In the preceding example, if the period one marginal production cost of unit fifty is $20, holding cost is $6 per unit held, and the period two marginal production cost of unit sixty is $30, it was rational for firms to hold some inventory to avoid some of the increasing marginal production cost. After the imposition of §263A, if the period one marginal production cost of unit fifty increases to $21, holding cost increases to $7 per unit held, and the period two marginal production cost of unit sixty increases to $34, it is rational for firms to hold more inventory and shift some production from period two to period one to avoid the large holding cost and period two production cost increases. The increase in inventory and the shift in production from period two to period one occurs because the increase in period one production cost is less than the sum of the increases in holding cost and period two production cost.

The preceding paragraphs demonstrated that production over the life of the firm will decrease because of §263A, but the change in production each period is ambiguous because

it is not clear whether costs increase more in the first or second period. The ambiguities exist because production one period and the resulting inventory holding that year are substitutes for production in the following period. Although the precise directions of the changes in present and future production and inventory holding are ambiguous, it is clear that the results depend upon the relative increases in production cost between the two periods and the increase in holding cost. The mathematics of optimization of firm profit gives insight into the changes in equilibrium production, inventory holding, and input combinations caused by changes in tax law.

The discussion in the previous chapters argues that §263A affects efficiency because firms change input decisions and equilibrium because firms change output decisions. As a result, both effects on firm behavior are studied in this research. The analyses in 1.3.3, 4.0, and Appendix B show that uniform capitalization is less efficient than the prior law and changes firm input and output decisions to less profitable levels that use more societal resources to produce fewer goods than under the prior law. The analyses in 1.3.2, 5, and Appendix C predict that equilibrium production and inventory holding decrease and specifies the circumstances in which decreases occur. A change in equilibrium is not necessarily evidence that the firm or the economy is better off or worse off than under prior law. The efficiency analysis is necessary to show that the economy is worse off.

1.2 *Legislative History*

A firm's taxable income equals revenues earned minus all fixed and variable expenses including cost of the goods sold, selling expenses, and administrative expenses. Cost of goods sold is determined by adding beginning inventory to cost of goods purchased or produced and subtracting ending inventory. Therefore, if the tax valuation of ending inventory increases, cost of goods sold decreases, taxable income increases, and tax payments increase. As a result

of these relationships, inventory rules in the tax code affect inventory carrying values, cost of goods sold, taxable income, tax payments, and cash flows.

Full absorption costing required under §471 mandates that manufacturing firms include both direct and indirect manufacturing and storage costs in inventory for tax purposes.[4] Section 1.471 regulations do not apply to retail, wholesale, and service firms. Section 1.471-11(c)(2) classifies various indirect fixed and variable costs as (in accounting terms) category 1 (pure manufacturing cost), category 2 (pure administrative and selling costs), and category 3 (a mixture of manufacturing, finished goods storage, and administrative costs). These regulations require that some fixed and variable category 1 costs be included in inventory and deducted from taxable income when the finished goods are sold, rather than when the costs are incurred. The remaining category 1 costs are expensed or inventoried according to the way the cost is treated in the taxpayer's financial accounting reports. Category 2 costs are expensed in the current period. Category 3 costs are included or excluded from inventory according to the way the cost is treated in the taxpayer's financial accounting reports. Given the option, taxpayers tend to expense category 1 and category 3 costs in the current period.

Uniform capitalization required under §263A was added by the Tax Reform Act of 1986. It extends to retailers and wholesalers [Committee on Finance, 1986], but not service firms, the general rules of §471 that were previously applied only to manufacturers, and increases the number of different manufacturing and storage costs that must be charged to inventory.[5] Section 263A also requires a portion of mixed costs be charged to inventory instead

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[4] The terms production cost and holding cost are used in this research to include all the economic costs of producing and holding goods respectively. Production cost includes all the costs to get a good produced and to the ultimate consumer. The terms manufacturing cost and storage cost are used in this research to specifically refer to definitions in §471 and §263A. The decrease in the effective tax rate on the deductions for category 1 (manufacturing-cost) and category 3 (mixed-cost) inputs creates the increases in production and holding output costs.

[5] See table 1 [Seago, 1987] following the appendices to this dissertation for a list of these items. Note that straight line depreciation is inventoried under both §471 and §263A. The excess of accelerated over straight line depreciation is inventoried only under §263A, however. One can think of straight line depreciation and the excess of accelerated over straight line depreciation as two different cost categories. The assignment of the excess of accelerated over straight line depreciation to inventory increases the number, but not the magnitude, of different manufacturing and storage costs that must be assigned to inventory. The same logic applies to idle capacity costs, interest [Richardson and Seago, 1989, Seago and Richardson, 1989] and the excess of percentage depletion over cost depletion.

of giving the taxpayer the option to expense or to capitalize. The §263A charges are in addition to the charges previously required under §471 [Seago, 1987] and therefore strictly increase the carrying value of inventories for tax purposes. Section 1.263A Temporary Regulations [May 24, 1987] also define costs by referring to §471. Increasing the number of costs capitalized and increasing the number of firms covered by the provisions increases compliance costs because firms must gather information and hire people to perform the calculations. The effect of compliance costs is not explicitly modeled in this research. Halperin [1979] models the effect of compliance costs.

Increasing the number of industries covered by the capitalization rules decreases the effective tax rate on the deduction for production and holding costs for the new group of firms firms covered by §263A and increases the after-tax cost of production and holding. Firms may respond to this provision of §263A by shifting to service industries to escape the capitalization rules. Increasing the number of cost categories subject to the uniform capitalization rules increases the number of cost categories that have a decreased effective tax rate on the deduction for category 1 and category 3 items and an increased after-tax cost for these same items.[6] Firms may respond to this provision of §263A by substituting category 2 items that are not covered by §263A such as advertising for category 1 and category 3 items that are covered by §263A such as quality control. If §263A is more distorting than §471, the effect of the shift of industries and the shift of inputs is that firms and the economy will incur higher costs than were incurred under §471 (otherwise, the new industries and input combinations would have been chosen under §471).

In summary, §263A has two effects that increase the capitalization required. First, §263A increases the number of firms covered by the capitalization provisions from manufacturers only to manufacturers, retailers, and wholesalers.[7] Service firms are excluded from

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[6] In particular, table 1 [Seago, 1987] following the appendices to this dissertation shows that raw materials storage costs (category 1) and finished goods storage costs (category 3) were not required to be capitalized under §471, but are required to be capitalized under §263A.

[7] More precisely, §471 applies to manufacturing activities and §263A applies to manufacturing and resale activities. Neither act applies to service activities. This project assumes that manufacturing firms are in-

coverage under both §471 and §263A. Section 263A also increases the number of allocations required for each manufacturing, retailing, and wholesaling firm. Section 263A encompasses §471 and strictly extends the scope of the cost assignments required.

Uniform capitalization was effective for tax years starting after December 31, 1986 and required that firms use the new rules both for beginning inventory the year the act became effective and future inventory acquisitions. The beginning inventory was revalued as if the §263A rules had been in effect in all prior periods and was considered to be an accounting change initiated by the taxpayer under §481(a). The adjustment to beginning inventory in the year of the change increased taxable income by the amount of the change in capitalization times the amount of inventory. The actual increase in tax payments was usually spread over a four year period [§1.263A-1T(e) and §481(a)]. The inventory adjustment had the one-time effect of increasing the present value of future tax payments by the sum of one fourth of the amount of the adjustment each year for four years times the present value of the marginal tax rate in effect each year. This adjustment is equivalent to and is modeled in chapter 5 as a single outflow that equals the present value of each of the four future additional tax payments. This one-time increase in taxable income is referred to as a §481 adjustment. The economic effect of the §481 adjustment is modeled in equation 5.1.7 and is analyzed in appendix C.1.

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volved in manufacturing activities, and service firms are involved in service activities. It is possible, however, for manufacturing firms to undertake service activities, etc.

1.3 Economic Analysis of the Law

1.3.1 Intuitive Analysis

Treasury II [The White House, p. 202] argued that §471 was deficient in several respects. First, "appropriate" matching [Gunn, 1984] of income and expense is not achieved when income is reported in one year and expense related to that income is reported in another year. Second, distortions in business decisions occur because of differential tax treatments. Third, inequities are created when taxpayers in lower marginal tax brackets are crowded out of multi-period activities by upper-bracket investors seeking tax deferral.[8]

Tax accountants attempt to defer costs and match them against income which is also deferred until the goods are sold. This deferral of revenues and expenses results in both items being taxed in the same tax period. It is difficult to determine exactly what is accomplished by good matching, however. Matching appears to be important if it leads to a true economic cost measurement that can be used to make profit maximizing decisions by the firm.[9] Profit maximizing behavior occurs when firms produce as long as marginal revenue exceeds marginal cost.[10] Marginal revenue is the incremental revenue earned because of a particular decision and marginal cost is the incremental cost incurred because of a particular decision (such as additional production, additional inventory holding, additional sales, etc.) Profit maximizing behavior requires the explicit use of marginal cost

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[8] High and low-income taxpayers have the same opportunity for tax deferral. High-income taxpayers have more incentive for deferral under a progressive tax system, however, because the marginal tax rate of high-income taxpayers is higher than the marginal tax rate of low-income taxpayers. This makes deferrals more valuable for high-income taxpayers. The crowd out argument is not an equity issue for lower income taxpayers, but is a residual of the progressive tax system. For a similar argument involving high income taxpayers that have identical tastes, see Rosen [1985, p.318].

[9] Matching might also include some concept of equity. One could argue that it is not equitable for one person to pay tax one period and another person to pay tax the following period on equivalent activities. The two taxpayers pay different effective tax rates, so this can be thought of as an efficiency issue. Efficiency is a less ambiguous argument because it results from profit maximizing behavior and does not depend upon a definition of equity which may vary from person to person.

[10] Marginal revenue is derived from the demand curve

concepts instead of vague statements about good matching. In summary, an efficient tax leads firms to make profit-maximizing decisions. Profit-maximizing decisions depend upon marginal costs, not matched costs. Therefore, tax policy makers must be concerned about measuring marginal costs, and not worry about matching of costs to revenues.

An efficient tax system does not require the measurement of costs that do not change (i.e., are not marginal) with respect to a certain decision for tax purposes. Therefore, if a cost (c) is not marginal with respect to a certain decision such as additional inventory holding (I) (i.e., $\frac{\partial c}{\partial I} = 0$), additional inventory is not relevant to cost decisions because additional inventory does not change cost.[11] For example, Temporary Regulations §1.263A require that certain administrative expenses be charged to manufacturing, and hence implicitly assume that these costs are marginal with respect to production.[12] While it is true that some administrative expenses are marginal with respect to production, it is not obvious that all administrative expenses are marginal with respect to production.[13] The difference in language between matching and marginal cost is important from an efficiency perspective because only marginal costs with respect to a given decision are relevant to that decision. Profit maximizing decisions and economic efficiency occur only when marginal costs are measured and used in making decisions.

Evans [1989] is in agreement with the general tone of Treasury II [The White House, p. 202] and argues that §263A leads to improved efficiency because uniform capitalization moves the tax system closer to the Haig-Simon [Stiglitz, 1986, p.420] definition of economic income. Haig-Simon define income to be any increase in one's net worth in real terms plus consumption during a period, without regard to the source of the increase. This seems to imply that income from all different

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[11] That cost may be sunk and thus should be expensed in the current period.

[12] This is in conflict with **Fort Howard Paper Co. v. Commissioner** (49 T.B. 275, 1967). **Fort Howard** implied that incremental costs are the only costs that must be inventoried for tax purposes.

[13] The uniform capitalization regulations illustrate the confusion in language between matching and marginal cost. Section 1.263A-1T(b)(6) refers to costs that " ...directly benefit or are incurred by reason of ... production". "Incurred by reason of production" is consistent with the marginal cost concept. The phrase "directly benefit" is difficult to interpret. For example, §1.263A requires idle capacity costs to be inventoried because they benefit future production. However, idle capacity is a sunk cost and sunk costs are not relevant to future decisions. Idle capacity should not be inventoried under a marginal cost concept, but is erroneously inventoried under the matching concept.

types of outputs is treated the same for tax purposes and there are no distortions because of differ-

ential tax treatment.

There are numerous fundamental departures from an economic definition of income in the

United States tax system. The United States system is generally transactions-based; it recognizes

revenue or expense when a transaction occurs that establishes the amount of the revenue or expense

that has been earned or incurred, instead of recognizing revenue and expense when changes in value

occur [Shakow, 1986].

The current system also departs from an economic definition of income because all industries

are not taxed comparably.[14] Section 471 applies to manufacturers, while §263A applies to man-

ufacturers, wholesalers, and retailers. Neither section applies to service firms. For example, the cost

of holding inventories of goods increases under §263A, but the cost of work in process performed

by service firms is not increased.[15] Firms may hold lower inventories of tangible goods relative to

inventories of service in process because of §263A. Holding lower inventories of goods appears to

be bad per se (i.e., a move away from efficiency), given that service companies were already given

preferential treatment because they were not covered under §471. The reduced level of goods in

inventory may be efficient if too much inventory was being held under the previous taxing scheme.

Sections 471 and 263A clearly have behavioral effects.[16] It is unclear whether the tax code led

to more or less efficient behavior before or after the implementation of §263A. Given that (a) there

are numerous departures from the Haig-Simon definition of income in the tax code, and (b) there

are unequal treatments of industries, second-best analysis[17] is necessary to show how uniform cap-

italization affects efficiency. This analysis is done in chapter 4 and appendix B.

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[14] Personal service corporations (such as accounting, consulting, engineering, legal, medical, etc.), or other corporations with gross receipts of less than $5 million, are not required to use the accrual basis of accounting under §446 and §448. The possible distortions caused by these exceptions are beyond the scope of this research.

[15] For example, accounting firms are not required to include in inventory the cost of an audit that has not been completed, but rather may expense the cost in the period incurred. This results in part of the expense of the audit being deducted in one period, while the revenue is taxed in a later period.

[16] In addition, §263A does not apply to production in foreign countries. Therefore, firms may shift production to other countries to escape the costs imposed by §263A. Domestic production is assumed in this research.

[17] First best analysis occurs when an unconstrained social optimum is achieved. Second best analysis is the

1.3.2 Equilibrium Analysis

Equilibrium (stability) in price and quantity occurs in a competitive market with free entry when price equals marginal and average cost. The equilibrium occurs because there are no potential profits to induce entrants and no losses to drive out present competitors. As a result, supply and demand determine price and quantity.

Partial equilibrium analysis allows one to focus on only one market and view it in isolation as if it were independent of all other markets [Miller, 1982]. In this analysis, all markets except the market(s) under study are held constant so that a restricted number of markets can be studied.[18]

The general equilibrium model relaxes the assumption that markets are independent of each other and examines all markets simultaneously. The general equilibrium framework is a sound theoretical approach to public sector problems because it makes no assumption about feedback effects. As a practical matter, it is difficult to model all markets and the interactions between the markets; hence, partial equilibrium is often assumed in early work for analytic tractability. Subsequent research can examine a general equilibrium model and determine whether or not a change or a failure in the market of interest has an impact and requires corrective action in other markets as well [Tresch, 1981, p.14].

A partial equilibrium analysis is presented in chapter 5. This analysis mathematically examines changes in production and inventory holding when production and holding costs are increased by changes in tax law. One would expect that present and future production and inventory holding decrease when costs imposed by a tax act increase, but chapter 1.1.2 argues that, since present production and holding is a substitute for future production, the result is ambiguous.

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social optimum subject to policy or other constraints such as a desired income distribution [Tresch, 1981, p. 3-6].

[18] Partial equilibrium analysis implicitly assumes that feedback affects do not exist. For example, if taxes in market A are changed, market B is affected to the extent A and B are substitute or complementary goods. The effect on market B in turn feeds back to market A. Partial equilibrium analysis assumes that the feedback effect from A to B to A does not exist. When the feedback is small, there is no grave consequence to using partial equilibrium instead of general equilibrium analysis.

Equilibrium analysis studies changes in economic behavior. No judgement is made concerning whether any change is good or bad for the firm or the economy.

1.3.3 Efficiency Analysis

Efficiency analysis goes beyond mere descriptions of equilibrium conditions and investigates whether one tax system is more efficient than an alternate tax system. A tax is defined as inefficient if it distorts unconstrained utility-maximizing or profit-maximizing decisions [Diamond and McFadden, 1974]. Inefficiency is bad for businesses because it reduces profitability. Inefficiency is bad for society because resources are wasted. The motivation of businesses to increase profits leads to improvements in society by minimizing the quantity of resources used.

Production of fewer goods may make the firm and society worse off. If two outputs are taxed at different effective rates under a new, inefficient tax act, producers and consumers will allocate resources to a different, less profitable combination of outputs than they chose before the act.[19] This may cause allocative inefficiency [Halperin and Srinidhi, 1987]. See chapter 4.0 and appendix A for more discussion of allocative efficiency.

Additionally, fewer goods may be produced because of a decrease in the effective tax deduction on some, but not all, productive inputs. If one input has a lower effective deduction under a new, more inefficient tax act than it had previously, producers will choose different, higher-cost input factors than they chose before the act.[20] This may cause productive inefficiency. The increased cost caused by productive inefficiency may cause lower production. See chapter 4.0 and appendix A for more discussion of productive efficiency.

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[19] If §263A is more distorting than §471, the new combination of outputs must be less profitable than the previous combination or it would have been chosen previously by a profit-maximizing firm.

[20] A profit-maximizing firm chooses the combination of production factors that has the the lowest after-tax cost. If a new, more inefficient tax policy causes a different combination of factors to be chosen, that combination must be higher cost or presumably that combination would have been chosen previously.

Whether a tax system leads to increased or decreased productive efficiency depends in large part upon what costs should be measured for tax purposes. See chapter 1.3.1 for more discussion of this issue. If producer and consumer choices are not efficient before a tax act, a change in equilibrium is not necessarily inefficient. For instance, if firms are producing an inefficient quantity of a particular output before the tax act, a decrease in production may be desirable because it is efficient.

In principle, taxes can be levied that are efficient because they are independent of the taxpayer's behavior [Rosen, 1985, p. 277-81]. These taxes are efficient because they do not distort taxpayer choices. That is, the same amount of tax must be paid without regard to the taxpayer's future input and output decisions. An efficient tax may not be practical or equitable, however. Efficiency in taxes may be sacrificed for the sake of equity. Social welfare is strictly improved according to the Pareto optimality criterion, when the efficiency of a tax subject to an income distribution requirement is strictly improved until no one player in the market can be made better off by a change in the tax policy without making another player worse off. This means that improvements in efficiency unambiguously improve societal welfare as long as the tax has no equity gains or losses. Any further changes would have a distributional impact and could reduce social welfare. Efficient taxes are examined in more detail in chapter 4.0.

Section 263A may have efficiency implications because the §263A allocations increase after-tax category 1 (manufacturing) and category 3 (a mixture of production and administrative) costs[21] by deferring the tax deduction for these items. Because §263A does not apply to category 2 (pure selling and administration), the after-tax costs of these items has not changed. Clearly, the after-tax costs of category 1 and category 3 inputs have increased relative to category 2 inputs, and one could expect to see firms substitute items in category 2 for items in categories 1 and 3. As a result of the tax constraint, the firm may choose a different combination of inputs that is more costly than the original combination of inputs and therefore is inefficient. For example, quality control is a category 1 item and is capitalized into inventory cost for tax purposes, while advertising is a category

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[21] See chapter 1.2 for a definition of category 1,2, and 3 costs

2 item and is not capitalized into inventory cost for tax purposes (see Table 1 at the end of this dissertation). Capitalizing the cost of quality control under §263A increases the after-tax cost of this input relative to advertising, causing firms to shift some resources from quality control to advertising. If §263A results in more inefficient behavior than §471, this shift in resources is more costly because the tax code induces firms to use inputs in combinations that they would not otherwise have used. The new input combination must be more expensive or else the profit maximizing firms would have chosen this combination previously.

Section 263A may also have efficiency implications because service activities are not subject to §471 and §263A capitalization rules. An accrual basis taxpayer subject to §263A normally capitalizes production costs and defers the deduction for these costs until the good is sold. For example, if an accounting firm were subject to the rules of §471 and §263A, it would be required to capitalize the costs of an audit, and charge these costs to expense when the audit is complete. Because accounting firms are service concerns and not subject to the rules of §471 and §263A, the audit costs are not capitalized, but are charged to expense and deducted in the period incurred. By comparison, if manufacturing firms hold inventory, direct and allocated manufacturing costs are capitalized for tax purposes, thereby increasing the after-tax cost of manufacturing activities relative to service activities. Manufacturing firms were at a tax-cost disadvantage under §471 compared to service firms, and §263A makes the disparity even more pronounced. One could argue that manufacturing firms may undertake service activities because of the tax rules, resulting in a different combination of outputs that is less profitable than the original unconstrained combination of outputs. The firm is worse off because it chooses a less profitable combination of outputs. Society is worse off because the choice of goods to consume is distorted away from the optimum by the tax barrier.

Assuming they hold inventory, retail and wholesale firms are also at a tax-cost disadvantage when compared to service firms because they are now covered by §263A capitalization rules. As a result, retailers and wholesalers may also undertake service activities because service firms have a strictly advantageous treatment under the capitalization rules. A mathematical model will be constructed in 4.2 to facilitate a more complete analysis of the problem.

2.0 LITERATURE REVIEW

The literature reviewed in this chapter guides this research in several areas. Seago [1987] gives the legal background of the problem, shows that §263A strictly encompasses §471, and suggests allocation rules that are acceptable under §1.263A. Seago [1987] is discussed in chapter 2.1. Evans [1989] links legal and economic analysis of uniform capitalization. Evans [1989] is discussed in chapter 2.2. Accounting research in efficient cost allocations, productive efficiency, and allocative efficiency is discussed in chapter 2.3. Halperin [1979] links efficiency analysis to tax accounting problems for inventory. This type of analysis is applied to develop the decision model used in chapter 4.0. Kaplan and Thompson [1971], Kaplan and Welam [1974], and Zimmerman [1979] suggests efficient cost allocation techniques. Economics research in tax issues [Gravelle and Kotlikoff, 1989] is contrasted to accounting research in tax issues and is discussed in chapter 2.4.

2.1 The Legal Problem

Seago [1987] reviews the uniform capitalization rules and includes a listing of the costs that must be allocated under §471 and §263A and a description of how the allocations are performed.

Section 263A and §1.263A-1T set forth rules for charging costs to manufacturing (i.e. inventory) as follows [Garrett, 1987 and Roth, 1988]:

1. Classify costs as pure manufacturing (category 1), purely selling and administrative (category 2),[22] or a mixture of manufacturing, selling, and administrative activities (category 3).[23]

2. Allocate mixed costs to manufacturing, sales, and administration. Mixed costs are allocated to particular activities or functions on the basis of a factor or relationship that reasonably relates the incurring of the service costs to the benefits received by the activity.

3. Allocate total manufacturing costs (including pure manufacturing costs and mixed costs allocated to manufacturing) to inventory and cost of goods sold. Total manufacturing cost is allocated proportionally between the number of goods sold and the number of goods retained in ending inventory. If no inventory is retained, there is obviously no capitalization required.

Seago [1987, p.1165] shows one (of many) simplified formulas [Guarascio and O'Connor, 1989] that may be used to allocate mixed costs to manufacturing [Temp. Reg. §1.263A-1(b)(5)(ii)] (the variable names have been changed to more easily reflect the costs described):

$$AC_j = MS_j \times \frac{PR}{TC} = MS_j \times \Theta \qquad\qquad 2.1.1$$

Where:

AC_j = The part of a particular mixed cost j that is allocated to manufacturing and then to inventory.

MS_j = A particular mixed cost j (category 3) that will be partially allocated to manufacturing and then to inventory.

PR = Total pure manufacturing cost (category 1).

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[22] Section 263(A) clearly defines these costs as executive, financial (not managerial) accounting, legal, and marketing and require that "no substantial part...directly benefit a particular production...activity."

[23] Category 1 and the portion of category 3 costs allocated to manufacturing are inventoried and charged to expense when the goods are sold. Category 2 and the portion of category 3 costs allocated to selling and administrative expense are charged to expense in the period the costs are incurred.

TC = Total costs other than mixed costs and interest.

Θ = A constant ratio = $\frac{PR}{TC}$. The ratio represents the proportion of mixed costs that are allocated to inventory.

Equation 2.1.1 shows that each particular type of mixed cost can be allocated to manufacturing and then inventory in a ratio that is fixed across all categories of mixed cost. The effects on efficiency and equilibrium of the simplified method [Joint Committee on Taxation, 1986] will be examined in chapters 4.0 and 5.0 and appendices B and C.

Seago [1987, p.1165] argues that the simplified method is biased toward allocating more than true manufacturing costs to inventory, especially for small business. The overvaluation of inventory occurs because an assumption underlying the simplified method (Equation 2.1.1) is that the proportion of manufacturing costs in mixed items is the same as the same proportion of manufacturing costs are in total costs (excluding mixed items). The scale of small business is such that employees perform multiple job functions, forcing virtually all non-manufacturing costs to be treated as mixed items (MS_j in 2.1.1 above). These multiple job functions suggest that PR nearly equals TC and therefore virtually all mixed costs will be charged to inventory under the simplified method. Charging such a high proportion of mixed costs to manufacturing results in an overstatement of inventory and taxable income because virtually all costs that are a mixture of manufacturing, selling, and administrative activities are assumed to be manufacturing costs. Firms can choose to use more sophisticated allocation methods, but at the cost of increased compliance effort.

The above arguments imply that arbitrary allocations[24] that depart from marginal costs do not achieve good matching and distort decisions. The big firm/small firm difference is not directly addressed, but the discussion centers on what happens to firms as more costs are allocated to manufacturing.

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[24] The term arbitrary allocation is used in this research to mean a cost allocation that does not result in marginal costs being assigned to production. The cost allocation is not strictly arbitrary in that there is some rationale behind the calculation (such as overhead being assigned to products on the basis of square footage), but it is arbitrary in that marginal costs are not assigned.

2.2 Economic Analysis of the Legal Problem

Evans [1989] applied economic analysis to §263A and asserts that uniform capitalization is an improvement in the horizontal equity of the tax code because the uniform capitalization system moves toward the Haig-Simon economic definition of income. Haig-Simon define income as the money value of the net increase to an individual's power to consume during a period [Rosen, 1988, p.348]. Under the Haig-Simon definition, all income is taxed when value increases, not when a transaction occurs. It was asserted in 1.3.1 that horizontal equity issues of this type are really efficiency issues. One could argue that it is not equitable for one person to pay tax one period and another person to pay tax the following period on equivalent activities. The two taxpayers pay different effective tax rates, however, so the equity issue can be addressed within the context of efficiency. Efficiency is less ambiguous because it results from profit maximizing behavior and does not depend upon a definition of equity, which may vary from person to person. Evans [1989, fn.9] implicitly asserts that uniform capitalization is an improvement in the tax code because it moves toward the Haig-Simon economic definition of income as the criterion for efficiency. Evans did not specify whether he was referring to productive or allocative efficiency, but used the Haig-Simon criterion which seems to imply that income from all different types of outputs is treated the same for tax purposes and there are no distortions because of differential tax treatment. If this is the case, he was asserting that §263A causes an improvement in the combination of outputs chosen. This is an allocative efficiency issue.

When the Haig-Simon definition for taxable income is followed, economic costs for all opportunities are measured, and the resulting behavior is efficient behavior because there are no differential tax treatments of outputs. Applying the Haig-Simon criterion to taxable income results in unconstrained profit-maximizing decisions. In the Evans model of long run competitive equilibrium, inventory is sold at a price that equals total production cost. According to Evans, inventory must be "worth" the current selling price and should be valued for tax purposes at selling

price.[25] Selling price equals total production cost (including production, selling, administration, and interest) according to Evans. Evans concludes by arguing that various provisions of §263A lead to an inventory valuation that approximates full cost of production, sales, and administration. This valuation results in a better measurement of Haig-Simon income.

The problem with the Evans analysis is that he does not distinguish between productive and allocative efficiency. The Haig-Simon model of income seems to address the issue of allocative efficiency of outputs. Evans frames his arguments in the context of inputs, which are measured by productive efficiency.

The Evans analysis can be improved in at least three ways. First, §263A can be modeled to see if the intuitive Evans analysis holds analytically. Second, a more explicit reference to economics theory will show whether §263A has allocative or productive efficiency implications. Third, the economic rationale for holding inventories can be included to see if the economic rationale changes the underlying arguments.

Firms in a long-run competitive market can sell all the goods they wish at the exogeneously given market price. Presumably firms would prefer to sell than to hold inventory. See chapter 1.1.1 for discussion about why firms hold inventory. Evans also asserts that in long-run competitive equilibrium, price is exactly equal to the total economic cost of production, including selling and administrative items. The more precise statement is that, in long-run competitive equilibrium (i.e., there has been entry and exit), price is bid down until it exactly equals both long-run marginal cost and minimum long-run average cost. But, to which decisions are these marginal and average costs marginal and average? For instance, materials cost is marginal with respect to producing a unit, but a sales commission is marginal with respect to selling a unit. This research improves upon the Evans analysis (1) by analytically modeling the effects of §263A, (2) by performing theoretically sound allocative and productive efficiency analysis, (3) by explicitly including an economic rationale for holding inventory, and (4) by considering the effect of more precise definitions of marginal costs.

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[25] Evans is not correct in this analysis. The fact that firms hold inventory indicates that the inventory must be more valuable in the future than it is in the current period. See chapter 1.1.1 for analysis of why firms hold inventory.

Uniform capitalization is at best a cost-based system and cannot capture subtle economic nuances. For instance, §263A assigns idle capacity cost to inventory [§1.263A-1T(b)(2)(vii)]. Idle capacity has an opportunity cost of zero. Assigning idle capacity cost to inventory, therefore, results in an overstatement of cost. As the result, uniform capitalization inherently does not fully meet the Haig-Simon criterion because it is an expired cost-based system, rather than an opportunity cost-based system. Even if the Evans model more closely approaches an economic definition of income, it is not clear that a system with remaining substantial departures from economic income results in more efficiency than the prior model. The efficiency model in chapter 4.0 will facilitate this analysis.

In spite of these criticisms, the basic premise that uniform capitalization leads to a more efficient tax system is interesting and worthy of further analysis.

2.3   *Accounting and Tax Research in Cost Allocations*

With the exception of Robert Halperin, accounting researchers have done little analysis of equilibrium and efficiency effects of changes in tax policy. Cohen and Halperin [1980] compute optimal inventory ordering strategy by constructing a three-period, deterministic, profit maximizing model that captures the trade-offs between production cost, holding cost, and LIFO inventory layer liquidation cost using a linear programming example. Unfortunately, linear programming does not allow for endogeneous input substitutions and the resulting efficiency effects. The model presented in this research allows for input substitutions, and shows the general direction of changes in production and inventory holding when taxes change. Both models take the LIFO/FIFO choice as given.

Halperin [1979] analytically studies LIFO inventory and shows that, under certain conditions, the imposition of tax leads to inefficient input and output combinations (including tax compliance activities that he considers to be outputs) as defined by Pareto optimality. Specifically, he demonstrates that using LIFO for tax purposes causes maintenance of excess year-end inventory to be

profitable. This is inefficient because the economy would be better off if the firm used its resources to produce goods instead of using resources to hold excess inventory. Halperin suggests alternative tax treatments that could achieve the same policy objectives without the inefficiencies of LIFO. This suggests that there may be uniform capitalization schemes that achieve stated policy objectives with reduced efficiency losses.

Management accounting has a rich tradition of research in cost allocations that may be relevant to the problem of tax allocations. Kaplan and Thompson [1971] and Kaplan and Welam [1974] use linear and non-linear approaches to the analysis of allocation techniques that do not distort managerial behavior. In principle, allocations of historical cost that approximate the marginal revenue product of scarce resources are efficient. This same principle may also hold for tax allocations. Appendix A shows that firms produce as long as the marginal revenue product of production is greater than or equal to the marginal cost of production. Therefore, the relevant costs appear to be marginal production costs (net of tax).

Zimmerman [1979] asserts that allocations of costs for managerial accounting purposes under certain conditions can serve to increase firm profits and firm value because variable costing leads to over-utilization of scarce resources. The logic of Zimmerman's argument is that profit-maximizing firms should produce as long as marginal revenue is greater than or equal to marginal cost, but true marginal cost is expensive to observe and measure. To the extent that cost allocations proxy for true marginal cost, cost allocations can be the second best solution for internal firm resource allocations, given the the expense of observing true marginal cost. The Zimmerman conclusion suggests that only true marginal costs should be assigned to inventory for income tax purposes.

In short, the managerial accounting literature on cost allocations is valuable because it lays the foundation for efficient allocation techniques that do not distort managerial decisions.

2.4 Analytic Modeling of Tax Issues in the Economics Literature

There is substantial economics literature concerning the efficiency of various tax issues [Slemrod, 1990]. The research, however, tends to view taxes in general and not model specific provisions of the tax code. In addition, the economics literature tends to assume specific functional forms for production technology, consumer utility, and social welfare and parameters for these functions. Simulations before and after a particular tax are run and efficiency measures are computed [Goulder and Thalmann, 1990, Gravelle, 1989 and Gravelle and Kotlikoff, 1989]. For other examples of this type of research, see Auerbach [1989], Ballard [1988], Ballard, Shoven, and Whalley [1985], Browning [1987], Chamley [1985a and 1985b], Clarete and Whalley [1987], Clotfelter [1983], Judd [1987a and 1987b], Kay and Keen [1988], Myles [1987], Pines, Sadka, and Sheshinski [1985] and Svensson and Weibull [1987]. This dissertation contributes to the literature by modeling a specific provision of the tax code while making no non-mathematical assumptions about the production technology.

3.0 RESEARCH QUESTIONS, PROPOSITIONS, AND METHODOLOGY

3.1 *Research Questions*

The discussion so far has suggested that uniform capitalization may have efficiency and equilibrium implications. With this in mind, the research questions of interest are:

1. What are the behavioral effects of uniform capitalization on productive and allocative efficiency?

2. What are the behavioral effects of uniform capitalization on inventory holding and production?

3.2 Research Propositions

The preceding research questions suggest the following propositions that are proven in this research:[26]

P_0^1:   Uniform capitalization leads to productive inefficiency (i.e., use of inputs that are not unconstrained cost minimizing).

Chapter 1.1.2 demonstrates that §263A increases the number of cost categories that must be capitalized for tax purposes, and increases the after-tax cost of these inputs. Increasing the after-tax cost of some, but not all, inputs causes firms to substitute one input for another in an attempt to reduce the after-tax cost of production and inventory holding. The shift in resources is productively inefficient because the tax code induces firms to use inputs in combinations that they would not have otherwise used. This new input combination results in higher production costs.

This proposition is proven analytically by constructing a profit maximizing model of a firm subject to uniform capitalization. Cost minimizing firms use input combinations for which the ratio of the marginal products of the two inputs (i.e., the marginal rate of technical substitution between the two inputs) equals the price ratio of the two inputs. This relationship is also true for any firm in any industry that uses the same inputs. Uniform capitalization requires cost allocations that create additional marginal rates of technical substitution for inputs that are not identical across firms and across industries. The conclusion is that uniform capitalization leads to productive inefficiency. See chapter 4.0 and appendix A for a more complete development of this theory.

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[26] Empirical research states a null hypothesis that can be statistically rejected with a certain probability because the researcher is sampling from a population that may (or may not) be representative of the general population. If the null is rejected, the alternative hypothesis is not accepted, but the rejection of the null gives some evidence for the alternative. In this case, the propositions are mathematically proven, given the assumptions of the model instead of mounting statistical evidence.

P_6^2:   Uniform capitalization does not lead to allocative inefficiency (i.e., production of outputs that are not unconstrained profit maximizing).

Chapter 1.3.3 shows that, if two outputs are taxed at different effective rates under an inefficient tax act, producers and consumers will allocate resources to a different, less profitable combination of outputs than they would have chosen before the tax act. The argument is that §263A may have allocative efficiency implications because service firms are not subject to sections 471 and 263A capitalization rules and therefore service firms have a cost advantage when compared to manufacturing and retailing firms. As a result, some manufacturing and retailing firms may undertake service activities because of the tax rules, resulting in a different combination of outputs that is less profitable than the original unconstrained combination of outputs. This loss of profitability is the result of allocative inefficiency. Section 263A, however, is a tax on inputs, not a tax on outputs. Therefore, §263A does not lead to allocative inefficiency. It is true that firms choose a different combination of outputs than they chose before §263A, but the combination is allocatively efficient, given the productive inefficiencies.

This proposition is proven analytically by constructing a profit-maximizing model of a firm subject to uniform capitalization. Profit maximizing firms produce output combinations such that the ratio of the marginal costs of the two outputs (i.e., the marginal rate of product transformation between the two outputs) equals the price ratio of the two outputs. This relationship is true for any firm in any industry that produces the same outputs. If uniform capitalization creates additional marginal rates of product transformation that are not the same as the marginal rate of substitution for consumers, then one can show that uniform capitalization leads to allocative inefficiency. See chapter 4.0 and appendix A for a more complete development of this theory.

P_6^3:   Uniform capitalization leads to a decrease in the equilibrium quantity of inventory held.

Chapter 1.1.2 argues that §263A increases holding costs. The increase in holding costs results in fewer units being held. This proposition is proven analytically by constructing a profit maxi-

mizing model of a firm subject to uniform capitalization. The change in inventory held in this model is examined as uniform capitalization is imposed.

P_o^4:   Uniform capitalization leads to a decrease in equilibrium output.

Chapter 1.1.2 argues that §263A increases production costs. The increase in production costs should result in fewer units being produced. It is not clear, however, that both production and inventory holding decrease each period when the effective tax rate on the deduction for each decreases. This ambiguity exists because production one period and the resulting inventory holding that period are substitutes for production in the following period. Although the precise directions of the changes in present and future production and inventory holding are ambiguous, it is clear that the results depend upon the relative increases in production cost between the two periods and the increase in holding cost.

This proposition is proven analytically by constructing a profit maximizing model of a firm subject to uniform capitalization. The change in output in this model is examined as uniform capitalization is imposed.

P_o^5:   The §481 adjustment has no impact on future inventory holding and production decisions.

The mechanics of the §481 adjustment are described in chapter 1.2. In Chapter 5.3, it will be shown that §263A retroactively applies the new capitalization rules to the existing stock of inventory under §481. Equation 5.1.7 shows that the §481 adjustment appears to be a lump-sum tax because it was levied retroactively on inventories held before the act was adopted and does not appear to distort future production or inventory holding decisions. The inventory, however, will eventually be sold and the higher carrying value for tax purposes might affect future decisions.

The proposition that the §481 adjustment is a lump-sum tax is proven analytically by constructing a profit maximizing model of a firm subject to uniform capitalization. The results show

that changes in production and inventory holding are the same under a comprehensive and a cut-off approach. Therefore, the catch-up provisions of §481 have no effect on future production and inventory holding decisions. The comprehensive and cut-off approaches are discussed in chapter 5.3.

P_0^6:   The impact of the §481 adjustment is no different if the taxpayer chooses LIFO as opposed to FIFO for tax accounting purposes.

Chapter 5.3 shows that §263A retroactively applies the new capitalization rules to the existing stock of inventory under §481. The inventory subject to the catch-up adjustment will eventually be sold. If the producer uses FIFO, the inventory including the §481 adjustment is assumed to be sold and the cost deducted for tax purposes in the period §263A became effective. If the producer uses LIFO, the inventory is assumed to be sold and the cost deducted for tax purposes in a later period. The difference in the FIFO and the LIFO methods is the difference in the present value of the tax deduction for the inventory held when uniform capitalization became effective. One might think that taxpayer behavior is different under the alternate systems because the present value of the tax deduction for the §481 adjustment is larger under FIFO than under LIFO. Because the §481 adjustment is based on past decisions and is a lump-sum tax, the LIFO or FIFO choice has no impact on the production and holding decisions.

This proposition is proven analytically by constructing a profit maximizing model of a firm subject to uniform capitalization. Since changes in production and inventory holding resulting from the §481 catch-up adjustment are the same under the LIFO and FIFO cost flow assumptions, the LIFO vs. FIFO decision has no impact on future production and inventory holding decisions.

3.3 Methodology

The research question determines the appropriate research methodology. The first research question involves studying whether the behavioral effects caused by §263A are efficient or inefficient. A strictly intuitive analysis of the efficiency effects of §263A might be appropriate, but a mathematical process allows the exploitation of well-known efficiency criteria from the economics literature [Halperin, 1991]. Empirics are not appropriate at this point because analytical inquiry is necessary to provide an understanding of the sources of efficiency or inefficiency. After the sources of efficiency or inefficiency are understood, they can be measured, and the results of the present research used to develop empirically testable hypotheses about the sources of efficiency or inefficiency. The empirics can give magnitudes of the efficiency or inefficiency if magnitudes are of interest.

The second research question involves studying the behavioral effects on production and inventory holding caused by uniform capitalization. A strictly intuitive analysis of the effects might be appropriate in considering the theoretical implications of §263A, but a mathematical process allows the use of tools that are well known in the economics literature. In the process of solving equations, the mathematics forces consideration of nuances that might otherwise be ignored. After the mathematical equations are derived, intuition must follow. The analytics allow one to predict changes in behavior from §263A and suggest policy implications. Empirics are not appropriate at this point because the theory is evolving and there is little evidence of what is appropriate to examine until after the analytics are performed. After the mathematical analysis is complete, the results may be used to develop empirically testable hypotheses concerning the directions of changes in production and inventory holding. The empirics also will give magnitudes of the changes if magnitudes are of interest. For examples of empirical research in tax issues (and some methodology papers), see Ayers [1987], Bathke [1985], Binder [1985], Courtenay, Crum, and Keller, Downs and Hendershott [1987], Eckel and Vermaelen [1988], Foster [1980], Halperin and Lanen [1987], Leftwich [1981], Madeo and Pincus [1985], Nikolai and Elam [1979], Owens and Rogers [1985],

Schipper and Thompson [1983], Schipper, Thompson, and Weil [1987], Schneider and Solomon [1986], Schwert [1981], and Slemrod [1982].

4.0   EFFICIENCY THEORY AND MODEL

Chapters 1.1.2 and 1.3.2 argue that equilibrium output and inventory holding decisions will change because of the changes in capitalization rules. One might infer (correctly or incorrectly) that changes in production and inventory are bad for the firm and society per se. Equilibrium analysis, however, makes no normative statement about whether the firm and society at large are better off or worse off because of uniform capitalization. Chapter 4.3 demonstrates that efficiency analysis requires a comparison of efficiency before and after uniform capitalization to demonstrate that §263A is better or worse than §471.

In this chapter, a positive micro-economic model of firm profit-maximizing input and output decisions before and after uniform capitalization is developed and compared to known efficiency conditions. This allows conclusions as to whether society is better off or worse off under §263A than it was under §471. If there are no equity gains from uniform capitalization, and the efficiency of the model is reduced by this tax, consumers will be worse off because prices will rise, output will fall, and consumer surplus will decrease [Rosen, 1988, p300].

Pareto optimality is the usual criterion for public policy analysis and occurs when one person cannot be made better off without making another person worse off [Tresch, 1981, p26-37]. Pareto optimality holds in competitive markets when consumptive, productive, and allocative efficiency conditions are simultaneously met *independent of the underlying utility and welfare functions* .

Therefore, two societies could have different values concerning the allocation of resources, employment of labor, etc. and the efficiency conditions still hold.[27]

Consumptive, productive, and allocative efficiency are obtained when:[28]

| Consumptive Efficiency | $MRS^A_{h,\,h'} = MRS^B_{h,\,h'}$ | $\forall$ h, h' | 4.0.1 |

| Productive Efficiency | $MRTS^M_{L,\,L'} = MRTS^E_{L,\,L'}$ | $\forall$ L, L' | 4.0.2 |

| Allocative Efficiency | $MRS_{h,\,h'} = MRPT_{h,\,h'}$ | $\forall$ h, h' | 4.0.3 |

Where:

$MRS^A_{h,\,h'}$ = Marginal Rate of Substitution for person A between any outputs h and h'. If a consumer is maximizing utility, the MRS is the maximum rate that person A can exchange product h for product h', while maintaining the same utility (i.e., level of satisfaction) [Rosen, 1985, p. 587].

$MRTS^M_{L,\,L'}$ = Marginal Rate of Technical Substitution for firm M between any inputs L and L' for all ($\forall$) L = i,j,k (in all combinations of i,j,k). i,j,k are defined to be manufacturing costs, mixed costs, and selling and administrative costs respectively in chapter 4.2. If the firm is minimizing cost, the MRTS is the maximum rate that firm M can exchange the use of input L for the use of input L' (in producing output h), while maintaining the same output.

$MRPT^M_{h,\,h'}$ = Marginal Rate of Product Transformation for firm M between any outputs h and h'. If the firm is maximizing profit, the MRPT is the maximum rate that firm M can exchange the output of product h for the output of product h', while maintaining the same cost.

If an economy is not Pareto optimal before or after §263A, one cannot necessarily prove that the new tax law moved the economy closer or farther away from the Pareto optimal condition. Diamond and Mirrlees [1971] show, however, that if there is an optimal distribution of income,

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[27] See appendix A for a more complete development of this theory.

[28] Efficient allocation is an economic concept that occurs when efficient consumers and efficient producers are willing to exchange product h for product h' in the same ratio (see Equation 4.0.3). This leads consumers to allocate resources to utility maximizing activities and producers to allocate resources to profit maximizing activities. Cost allocation is an accounting concept that refers to the assignment of cost. This dissertation shows that cost allocations required by the tax code may lead to inefficient economic allocation.

increases in productive efficiency are desirable. It follows that decreases in productive efficiency are undesirable under the same set of circumstances.

Although the Diamond and Mirrlees result strictly holds under restrictive conditions (including the optimal distribution of income), one could heuristically argue that the result holds in less restrictive settings and assert that second best improvements in productive efficiency are potentially Pareto improving. The logic of this argument is that improvements in productive efficiency allow the firm to decrease the consumption of at least one input without harming the production of any good. The decreased consumption of input(s) may allow the production of more outputs. Surely at least one person is made better off by the decreased use of inputs and potential production of more outputs without making anyone worse off. If this is the case, then improvements in productive efficiency are Pareto improving [Tresch, 1981, p.31].

Based on the Diamond and Mirrlees result and its general heuristic interpretation, it is not necessary to prove that a tax policy action results in a movement toward or away from Pareto optimality. Rather, it is only necessary to show that there is an increase or decrease in productive efficiency and an effect on the Pareto optimal condition is assumed. Therefore, this dissertation will show where increased inefficiencies occur because of uniform capitalization and suggests policy actions that might decrease the inefficiencies.

4.1   The Input Model and Analysis

Economic modeling abstracts from total reality to study items of interest while making the ceteris paribus assumption. In a defense of experimental economics, Plott [1982] argues that what holds true in a simple special case also holds true in other more general cases; however, confounding factors may obstruct the item of interest in the more general cases. It is desirable to first study the simple special cases and draw inferences before enriching the model with all the real-world complexities.

Uniform capitalization is complex, and modeling all its provisions is difficult. To achieve some understanding of the problem, abstraction allows the basic theoretical issues to be isolated and addressed. This chapter develops a simple partial equilibrium micro-economic model of the firm's input choices before and after uniform capitalization.

There are two equivalent methods of modeling firm inputs and outputs. A firm can choose optimal inputs given a production technology. Combining the optimal inputs with the production technology yields the optimal outputs. In the dual, but equivalent problem, a firm can choose the optimal output combination for a given production technology. Combining the optimal outputs with the production technology yields the optimal inputs [Silverberg, 1978, p.309].

A study of productive efficiency investigates distortions in inputs; therefore, costs must be stated as a function of inputs. This study applies the basic Halperin [1979] idea of input costs to the uniform capitalization problem to analyze whether §263A leads to less efficient behavior than §471 alone and under what circumstances any inefficiencies occur. The results of the efficiency analysis suggest tax accounting rules (i.e., allocation procedures) that mitigate the inefficiencies. The dual, but equivalent, approach is used in chapter 5 to examine cost as a function of outputs.

4.2 Development of the Input Model

Assume that a profit-maximizing firm operates in perfectly competitive markets, the cost functions can be differentiated, there is zero inflation, and accounting, tax, and economic costs are identical except for the provisions of §471 and §263A.[29] Profit as a function of inputs can be stated as follows [Silverberg, 1978, p.309]:[30]

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[29] The implications of these assumptions will be examined in the limitations chapter.

[30] Tax accountants implicitly assume that input costs can conveniently be divided into fixed and variable components. These assumptions will be relaxed in future research.

$$\text{Max } \Pi \;=\; \sum_{h=1}^{H} R_h q_h [1-t] - \sum_{l=1}^{L} w_L x_L [1-t] - \sum_{L=1}^{l} F_L [1-t] \qquad\qquad 4.2.1$$

Where:

Π	$=$	Firm profit
t	$=$	The firm's tax rate $[0 < t < 1]$.
$\displaystyle\sum_{h=1}^{H} R_h q_h$	$=$	Total revenue where R_h is the selling price of the hth good and q_h is the quantity of the hth good sold.
$\displaystyle\sum_{L=1}^{l} w_L x_L$	$=$	Variable accounting and economic input costs when $1 =$ the number of inputs that are possible to use in the production process, w is the unit price of the variable cost of interest, and x is the quantity of the factor used.
$\displaystyle\sum_{L=1}^{l} F_L$	$=$	Fixed costs.

One could order all variable and fixed costs into manufacturing (i), mixed (j), and selling and administrative (k) cost categories as defined in §471. When this ordering is done, the profit function becomes:

$$\text{Max } \Pi \;=\; \sum_{h=1}^{H} R_h q_h [1-t] - \sum_{i=1}^{l} w_i x_i [1-t] - \sum_{j=1}^{J} w_j x_j [1-t] - \sum_{k=1}^{K} w_k x_k [1-t]$$

$$- \sum_{i=1}^{l} F_i [1-t] - \sum_{j=1}^{J} F_j [1-t] - \sum_{k=1}^{K} F_k [1-t] \qquad\qquad 4.2.2$$

Where:

$\displaystyle\sum_{L=1}^{l} w_L x_L$	$=$	The variable accounting and economic costs of manufacturing, mixed activities, and selling and administration when $L = i,j,k$ respectively. w is the unit price of the variable cost of interest and x is the quantity of the factor used.
$\displaystyle\sum_{L=1}^{l} F_L$	$=$	Fixed costs of manufacturing, mixed activities, and selling and administration when $L = i,j,k$ respectively.

An assumption underlying equation 4.2.2 is that the firm deducts all expenses in the period they are incurred. Sections 471 and 263A force the firm to allocate some portion (θ_L) of fixed and

variable costs to inventory $(\theta_L w_L x_L + \theta_L F_L)$ for tax purposes. θ_L is the proportion of fixed and variable costs assigned to inventory and is between zero and one inclusive. Costs not allocated to inventory are $(1 - \theta_L)w_L x_L + (1 - \theta_L)F_L$. If a cost is not allocated, θ_L equals zero. If the cost is fully allocated, θ_L equals one. If the cost is partially allocated, θ_L is between zero and one. Allocating cost to inventory causes the tax deduction to be deferred and discounted for the period of time (n) the inventory remains on hand $(\frac{\theta_L w_L x_L + \theta_L F_L}{(1 + r)^n})$, which lowers the effective tax deduction on this cost. The decrease in the effective tax deduction can be thought of as an increase in the effective wage rate of inputs for tax purposes (v_L^t) where $(v_L^t x_L = \frac{\theta_L w_L x_L + \theta_L F_L}{(1 + r)^n})$.

The effective cost for tax purposes of an input consists of the cost allocated plus the cost not allocated and can be thought of as $v_L^t x_L + (1 - \theta_L)w_L x_L + (1 - \theta_L)F_L$. If an input is required to be fully allocated, the effective cost for tax purposes is $v_L^t x_L$ because θ_L equals one. If the input is not required to be allocated, the effective cost for tax purposes is $w_L x_L + F_l$ because θ_L equals zero.

The firm's problem is to pick q_h, x_i, x_j, x_k, so that profits are maximized. Using the logic previously developed, equation 4.2.2 is changed as follows:

$$
\begin{aligned}
\text{Max } \Pi \; = \; & \sum_{h=1}^{H} R_h q_h - \sum_{i=1}^{I} w_i x_i - \sum_{j=1}^{J} w_j x_j - \sum_{k=1}^{K} w_k x_k - \sum_{i=1}^{I} F_i - \sum_{j=1}^{J} F_j - \sum_{k=1}^{K} F_k \\[2mm]
& - t[\sum_{h=1}^{H} R_h q_h - \sum_{i=1}^{I} v_i^t x_i - \sum_{i=1}^{I} (1 - \theta_i)w_i x_i - \sum_{j=1}^{J} v_j^t x_j - \sum_{j=1}^{J} (1 - \theta_j)w_j x_j - \sum_{k=1}^{K} v_k^t x_k] \\[2mm]
& - t[- \sum_{k=1}^{K} (1 - \theta_k)w_k q_k - \sum_{i=1}^{I} (1 - \theta_i)F_i - \sum_{j=1}^{J} (1 - \theta_j)F_j - \sum_{k=1}^{K} (1 - \theta_k)F_k], & 4.2.3
\end{aligned}
$$

with the following identities:

$$
v_i^t x_i = \frac{\theta_i w_i x_i + \theta_i F_i}{(1 + r)^n} \tag{4.2.4}
$$

$$
v_j^t x_j = \frac{\theta_j w_j x_j + \theta_j F_j}{(1 + r)^n} \tag{4.2.5}
$$

$$
v_k^t x_k = \frac{\theta_k w_k x_k + \theta_k F_k}{(1 + r)^n} = 0 \qquad\qquad \text{If } \theta_k = 0,\text{[31]}
$$

subject to:

$$g(q_1, q_2, \ldots, q_o) - h(x_1, x_2, \ldots, x_{I+J+K}) = 0, \qquad \text{4.2.7}$$

•

where:

$\sum_{L=1}^{I} w_L x_L$	=	The variable accounting and economic costs of manufacturing (i), mixed activities (j), and selling and administration (k) when L=i,j,k respectively. w is the unit price of the variable cost of interest and x is the quantity of the factor
$\sum_{L=1}^{I} F_L$	=	Fixed cost of manufacturing (i), mixed activities (j), and selling and administration (k) when L=i,j,k respectively.
$\sum_{L=1}^{I} v'_L x_L$	=	The effective *tax* costs of manufacturing and mixed activities after the imposition of uniform capitalization where L = i,j. v' is different from w because v' includes w and allocated fixed manufacturing costs, both discounted for the period of time held in inventory [Equations 4.2.4 and 4.2.5]. Tax law does not require that pure administration and selling costs be allocated and thus the effective and nominal wage rate are equal [Equation 4.2.6].
θ_L	=	Portion of manufacturing, mixed activities, and pure selling and administration cost required to be allocated to inventory when L = i, j, and k. If the cost is required to be allocated, $0<\theta_L\leq 1$. Otherwise, $\theta_L = 0$. No pure selling and administrative costs are allocated and deferred, so $\theta_k = 0$.
$(1 + r)^n$	=	The discounting factor (r) for the average period of time (n) inventory is retained.
$g(q_1, q_2, \ldots, q_o) = h(x_1, x_2, \ldots, x_{I+J+K})$.		The firm's multi-product production function expressed as a function of outputs [g(.)] and as a function of inputs [h(.)]. This function determines the quantity of each input that must be used to produce a certain combination of outputs. For example, if only one output is produced, g(.) is that output, and h(.) describes the inputs that are used.

---

[31] Under sections 471 and 263A, pure selling and administrative costs are not allocated to inventory and v'_k disappears because $\theta_k = 0$.

Line one of equation 4.2.3 is pre-tax revenue, variable and fixed manufacturing, mixed, and pure administrative and selling expenses. Line two and the first term of line three show the tax effect of revenue and variable expense where cost is, is not, or is partially allocated. As was previously discussed, each cost category has two terms to allow for allocation, no allocation, or partial allocation. The last three terms of line three show the effects of allocation on fixed costs. If the category is partially or fully allocated, part or all of the fixed cost is captured in $v_L^f q_L$. If the category is not allocated, the fixed cost is fully deducted in the period it is incurred.

θ_L is the portion of manufacturing, mixed activities, and pure selling and administration costs required to be allocated to inventory when L = i, j, and k. If the cost is required to be allocated, $0 < \theta_L \leq 1$. Otherwise, $\theta_L = 0$. Exhibit 4.2 that follows the next three paragraphs summarizes the values θ_L can take on under §471 and §263A assuming the firm is a manufacturer, a retailer, or a service concern. In general, manufacturing costs (category 1) are fully charged to inventory under §471, but §263A extended the number of manufacturing costs charged to inventory. As a result, $\theta_i = 0$ or 1. There are two categories of manufacturing costs. The first category includes manufacturing costs defined under §471. The second category includes the additional manufacturing costs defined under §263A.[32] The subscript ia in the exhibit refers to category 1 manufacturing costs when §471 and §263A agree on the definition. These costs are fully charged to inventory under §471 and §263A, so $\theta_{ia} = 1$. The subscript iu refers to the additional category 1 manufacturing costs defined under §263A. These costs are fully charged to inventory under §263A, but are not charged to inventory under §471. As a result, $\theta_{iu} = 1$ under §263A, but $\theta_{iu} = 0$ under §471. Retail and service firms do not have manufacturing costs, so manufacturing costs are not applicable to retail and service firms ($\theta_i = $ N/A).

The subscript k is used to designate category 2 pure selling and administrative costs. These costs are not charged to inventory under §471 or §263A, so $\theta_k = 0$ under §263A and §471. The subscript j refers to category 3 mixed costs. These costs were not required (but may) be charged to inventory under §471, and thus $\theta_j = 0$ is assumed. This assumption seems realistic given that

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[32] See table 1 at the end of this dissertation for examples of manufacturing costs required to be assigned to inventory under §263A that were not required to be assigned to inventory under §471.

firms attempt to maximize the present value of tax deductions. A portion of mixed costs is required to be charged to inventory under §263A, and thus $0<\theta_j\leq 1$.

Retail firms were not covered under §471, so $\theta = 0$ for retailers under §471. Retail firms are covered under §263A, so $0<\theta\leq 1$ for retailers under §263A. Service firms are not covered by §471 or §263A, so $\theta = 0$ or N/A for service firms.

Exhibit 4.2

Proportions (θ) of Category 1,2, and 3 Costs

That Are Allocated For Manufacturing, Retail, and Service Firms

Under §471 and §263A

	§471			§263A		
	Manufacturing	*Retailing*	*Service*	*Manufacturing*	*Retailing*	*Service*
Category 1						
$\S 471_{ia}$	1	N/A	N/A	1	N/A	N/A
$\S 263A_{iu}$	0	N/A	N/A	1	N/A	N/A
Category 2_k	0	0	0	0	0	0
Category 3_j	0	0	0	$0<\theta_j\leq 1$	$0<\theta_j\leq 1$	0

Where:

Category 1 ($\S 471_{ia}$) = Manufacturing costs that are charged to inventory under both §471 and §263A. The subscript ia is used in appendix B to indicate these manufacturing costs.

Category 1 ($\S 263A_{iu}$) = Additional manufacturing costs that are charged to inventory under §263A. These costs are charged to inventory under §263A, but were not charged to inventory under §471. The subscript iu is used in appendix B to indicate manufacturing costs that are charged to inventory under §263A, but not under §471.

Category 2$_k$	=	Pure selling and administrative costs that are not charged to inventory under either §471 and §263A. The subscript k is used in appendix B to indicate these pure selling and administrative costs.
Category 3$_j$	=	Mixed costs that are not required to be charged to inventory under §471, but that are required to be charged to inventory under §263A. The subscript j is used in appendix B to indicate these mixed costs.
Manufacturing	=	Firms involved in manufacturing activities that are covered under §471 and §263A.
Retailing	=	Firms involved in retailing activities that are not covered under §471, but are covered under §263A.
Service	=	Firms involved in service activities that are not covered under §471 or §263A.

4.3 Method of Analysis of the Input Model

To assess the efficiency effects of §263A relative to §471, one must compare the efficiency of each of the tax cost systems independently across firms within an industry and across industries. Appendix B.3 compares firms within industries (manufacturing, retail, and service) and appendix B.4 compares firms across industries. If §263A has all of the inefficiencies of §471 and adds more inefficiencies, or the inefficiencies of §263A are larger than the corresponding inefficiencies of §471, §263A is less efficient than §471 alone. Conversely, if §263A cures some of the inefficiencies of §471 while adding no more inefficiencies, or the inefficiencies of §263A are smaller than the corresponding inefficiencies of §471, §263A is more efficient than §471 alone. The analysis will be done using the criteria of equations 4.0.1 - 4.0.3. For example, the following contrived example is a comparison of productive efficiency between manufacturers and retailers under §471 and §263A:

	§471		§263A	
	Retailers	*Manufacturers*	*Retailers*	*Manufacturers*
$\text{MRTS}_{i,j} =$	$\dfrac{w_i}{w_j}$ $=$	$\dfrac{w_i}{w_j}$	$\dfrac{w_i}{w_j}$ $=$	$\dfrac{w_i}{w_j}$
$\text{MRTS}_{i,k} =$	$\dfrac{w_i}{w_k}$ $=$	$\dfrac{w_i}{w_k}$	$\dfrac{w_i}{w_k}$ $\neq$	$\dfrac{w_i(1 - t_e)}{w_k}$
$\text{MRTS}_{j,k} =$	$\dfrac{w_j}{w_k}$ $\neq$	$\dfrac{w_j(1 - t_e)}{w_k}$	$\dfrac{w_j}{w_k}$ $\neq$	$\dfrac{w_j(1 - t_e)}{w_k}$

The above example shows that retailers and manufacturers have equal $\text{MRTS}_{i,j}$ under both §471 and §263A. If the firm is minimizing cost, the $\text{MRTS}_{i,j}$ is the maximum rate that the firm can exchange the use of input i for the use of input j (in producing output h), while maintaining the same output. Any other combination would be more costly. By equation 4.0.2, retailers and manufacturers have combinations of i and j that are productively efficient under both §471 and §263A because $\text{MRTS}^R_{i,j} = \text{MRTS}^M_{i,j}$. Retailers and manufacturers have equal $\text{MRTS}_{i,k}$ under §471, but have a different $\text{MRTS}_{i,k}$ under §263A. As a result, combinations of i and k are productively efficient under §471, but are not productively efficient under §263A. In addition, retailers and manufacturers do not have equal $\text{MRTS}_{j,k}$ under either §471 or under §263A. As a result, combinations of j and k are not productively efficient under §471 or §263A. Therefore §263A is less efficient in this example than §471 because §263A maintains all the cases of efficiency of §471 [case 1], §263A creates distortions that did not exist under §471 [case 2], §263A does not cure any of the distortions of §471 [case 3], and thus §263A induces firms to use higher than unconstrained economic least cost production combinations. In short, resources are wasted because of the tax distortions.

The Diamond and Mirrlees [1971] result shows that productive inefficiencies move the economy away from the Pareto optimal point and therefore society is worse off unless there is some equity gain. Even if there is an equity gain, policy makers need to understand the resulting efficiency loss.

The analysis suggested in this chapter is performed in appendix B. Appendix B.1 shows that §471 and §263A lead to allocatively efficient behavior [proposition 2]. Appendices B.2 - B.4 show that §471 and §263A lead to productively efficient behavior [proposition 1].

4.4 Validation of the Input Model

The most common definition of validity is: Are we measuring what we think we are measuring [Kerlinger, 1986, p.416-418]? When physical properties or simple attributes are measured, validity is not troublesome because there is direct logical association between the object being measured and the measuring instrument. Content validity asks: Is the substance of this measure representative of the content of the theoretical property being measured? [Kerlinger, 1986, p.416-418]. In this case, a model of variable and fixed input costs under §471 and §263A is developed. Well-known economics theory and techniques are then used to examine the changes in efficiency between the two code sections. Therefore, the validity of this project is not difficult to establish.

Logically, there seem to be two general requirements for establishing the content validity of a mathematical model of a tax act. First, the final model must be deductively consistent with accepted economic models and the tax act under consideration. Second, the model developed must withstand sensitivity analysis and other logical tests. If both these requirements are met, validity appears to be supported.

In the case of the input model of §471 and §263A, a well known single period profit-maximizing model [equation 4.2.1] from the economics literature is used [Silverberg, 1990, p.251] and the variable and fixed inputs are ordered into category 1, 2, and 3 costs to capture the provisions of §471 and §263A [4.2.2]. The tax deductions are then discounted to reflect the holding of inventory [4.2.3 - 4.2.7]. By deductive reasoning, if the beginning model is valid and the modeling of §471 and §263A are valid, the final model is valid.

The final results computed are examined for reasonableness and for sensitivity to underlying assumptions. The method of proof is heavily dependent upon the mathematical assumptions of differentiability, but this research is more interested in the reasonable modeling of the tax code. Sensitivity analysis is done on 4.2.3 - 4.2.7 by substituting reasonable values for θ. Exhibit 4.2 shows that cost is fully allocated $[\theta = 1]$, partially allocated $[\theta_L = \theta_L]$, or not allocated at all $[\theta_L = 0]$. From 4.2.3, assuming the particular cost is fully allocated, $\theta_L = 1$:

$$v_L^i x_L + (1 - \theta_L) w_L x_L + (1 - \theta_L) F_L = v_L^i x_L = \frac{w_L x_L + F_L}{(1 + r)^n}$$

From 4.2.3 - 4.2.6, if the particular cost is not allocated, $\theta_L = 0$:

$$v_L^i x_L + (1 - \theta_L) w_L x_L + (1 - \theta_L) F_L = w_L x_L + F_L$$

These results show that the model reduces to an effective wage rate for tax purposes if the cost is allocated, or the pure economic wage rate when the cost is not allocated.

5.0 EQUILIBRIUM THEORY AND MODEL

It is argued in chapter 4.1 that a firm can choose the optimal inputs given a production technology of outputs, or equivalently the firm can choose the optimal outputs given the production of inputs. The model previously presented in this research examines changes in input productive efficiency and models costs as functions of inputs. In this chapter, changes in equilibrium production and inventory holding are studied and costs are functions of output production and inventory holding.

Recall the profit maximizing firm modeled in chapter 4.2. That firm operates in a perfectly competitive market, cost functions are twice differentiable with respect to all choice variables and parameters, there is zero inflation, and tax and economic costs are identical except for the provisions of §471 and §263A.[33] To justify holding inventory, assume that the firm faces positive and increasing marginal production cost (with respect to quantity produced and inventory held) and holding cost (with respect to inventory held) functions. After the models are developed, the changes in equilibrium production and inventory holding decisions created by the imposition of uniform capitalization are studied.

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[33] The implications of these assumptions are addressed in the limitations chapter.

5.1   Development of the Multi-Period Output Model

Consider a multi-period world in which prices periodically increase deterministically. From the arguments presented in 1.1.1, it is rational for firms to hold inventory. The amount of inventory on hand when §263A was first anticipated is fixed by past decisions and cannot be changed at this point (i.e., prior production and inventory holding are no longer choice variables). Firms are assumed to have a finite life and thus there is no inventory at the end of the last period. To capture the §481 adjustment in the first period, the effects of the LIFO/FIFO choice, and the final liquidation of inventory, a two period model is used. The finite remaining life of any firm can arbitrarily be divided into any number of time periods. Just two periods with an implicit prior period where inventory is first accumulated are chosen for study in this research.[34]

A simple one period competitive firm can be modeled (after tax) as [Chiang, 1984, p.247]:

$$\Pi = P_1[1 - t_1]q_1 - c_1(q_1)[1 - t_1] \qquad\qquad 5.1.1$$

Where:

Π	=	Firm profit
P_i	=	The price of the good in period i $[P_i > 0]$.
q_i	=	The quantity of the good produced and sold in period i $[q_i > 0]$.
$c_i(q_i)$	=	The firm's production cost in period i which is a function of quantity produced in that period $[c_i(q_i)$ and $\partial c_i(q_i)/\partial q_i > 0]$. $c_i(q_i)$ will not equal $c_{i+1}(q_{i+1})$ unless $q_i = q_{i+1}$. Production cost includes all costs to acquire the good and get it to the ultimate consumer, including manufacturing, marketing, and selling and administrative items.
t_i	=	The tax rate in period i $[0 < t_i < 1]$. t_i may or may not equal t_{i+1}.

---

[34] One could argue that inventory is a function of production in this model. However, inventory is a function of production if production *uniquely* determines inventory. In this model, total sales for the life of the firm are exogenously determined by market demand and production over the life of the firm equals sales. Production in *each* of periods is determined by the trade-off of increasing marginal production costs and increasing marginal holding costs. Therefore, inventory carried is a result of the mathematical relationship between sales and production, rather than a function of production because if production goes up, sales may also go up, leaving inventory unchanged.

The one period model can be easily expanded into a two period model in which all goods produced in the first period may not be sold:

$$\Pi = P_1[1 - t_1]S_1 - c_1(q_1)[1 - t_1] +$$

$$\frac{1}{1+r}[P_2[1 - t_2]S_2 - c_2(q_2)[1 - t_2]] \qquad 5.1.2$$

Where in addition to the terms previously defined:

S_i	=	The quantity of the good sold in period i $[S_i > 0]$.
q_i	=	The quantity of the good produced in period i $[q_i > 0]$.
$c_i(q_i)$	=	The firm's production cost in period i which is a function of quantity produced in that period $[c_i(q_i)$ and $\dfrac{\partial c_i(q_i)}{\partial q_i} > 0$
r	=	The discount rate $[0 \leq r \leq 1]$.

Logically, sales (S_i) in the current period equal current period production (q_i) plus beginning inventory (I_{i-1})[35] minus ending inventory (I_i), as follows:

$$S_i = q_i + I_{i-1} - I_i \qquad 5.1.3$$

Where in addition to the terms previously defined:

I_i	=	Units of inventory held at the end of period i $[I_i \geq 0]$.

If firms do not sell all of their production in a given period, inventory must be held. There are costs of holding inventory including storage, theft, breakage, etc. By substitution, the two period world can be expanded to explicitly include inventory and holding cost. There is no inventory or holding cost in the second period of the two period model. The present value of two period lifetime income is:

---

[35] Beginning inventory for period i equals ending inventory for period i-1.

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I_1] - c_1(q_1)[1 - t_1] - h_1(I_1)[1 - t_1] +$$

$$\frac{1}{1+r}[P_2[1 - t_2][q_2 + I_1] - c_2(q_2)[1 - t_2]]$$
<div align="right">5.1.4</div>

Where in addition to the terms previously defined [q_i and $c_i(q_i)$ are defined following 5.1.2]:

$h_i(I_i)$ = Economic inventory holding cost [$h_i(I_i)$ and $\dfrac{\partial h_i(I_i)}{\partial I_i} \geq 0$].

I_{0-k} = Beginning inventory in units that comes from an implicit prior period. The 0-k subscript indicates what period the inventory units came from. If the firm is a FIFO taxpayer, k equals zero. This indicates that the ending year 0 inventory came from year 0 production. If the firm is a LIFO taxpayer, k equals some number greater than zero. This indicates that the ending year 0 inventory came from production in periods prior to year 0.

Because of the §471 and §263A inventory capitalization rules, only the proportion of goods sold (to goods produced) times production and holding costs may be deducted for tax purposes in the current year. The proportion sold equals one minus the proportion not sold. The proportion of current production not sold each period equals ending inventory divided by current production ($\frac{I_i}{q_i}$). If all costs are required to be capitalized, the cost retained in inventory is the proportion just calculated times total cost including production, selling, and administrative items. Since generalized cost functions are used, the cost can be of any specification, including fixed, variable, or cost to any other power as long as the first and second order conditions are met. Algebraically, the after-tax production cost[36] each period is:

$$c_i(q_i)[1 - t_i[1 - \frac{I_i}{q_i}]] = c_i(q_i)[1 - t_i] + c_i(q_i)[\frac{I_i t_i}{q_i}]$$

The after-tax holding cost each period is:

---

[36] Production cost is defined in this research to include all costs to produce and take a good to market, including pure manufacturing, selling, and administrative items. This cost includes cost of goods sold, but also includes selling and administrative items.

$$h_i(I_i)[1 - t_i[1 - \frac{I_i}{q_i}]] = h_i(I_i)[1 - t_i] + h_i(I_i)[\frac{I_i t_i}{q_i}]$$ 5.1.5

Equation 5.1.5 implicitly assumes that all production and holding costs not sold must be assigned to inventory for tax purposes. Equation 5.1.6 includes a variable $(0 \le \Theta_j \le 1)$ that measures the proportion of cost that is required to be deferred under §471 and §263A. This proportion strictly increased when §263A was added to the previously existing §471 [Seago, 1987]. When $(\frac{I_i}{q_i})$ is multiplied by Θ_j and the cost function, the result describes the proportion of cost retained in inventory for tax purposes. The Θ_j converts the proportion of total cost (including production, selling, and administrative) to a proportion of tax cost. The portion of current production and holding costs that are *not* deducted in the current period are retained in ending inventory and are included in beginning inventory the next period. Thus, the after-tax production cost is given by

$$c_i(q_i)[1 - t_i[1 - \frac{\Theta_1 I_i}{q_i}]] = c_i(q_i)[1 - t_i] + c_i(q_i)[\frac{\Theta_1 I_i t_i}{q_i}].$$

The after-tax holding cost is given by

$$h_i(I_i)[1 - t_i[1 - \frac{\Theta_2 I_i}{q_i}]] = h_i(q_i)[1 - t_i] + h_i(q_i)[\frac{\Theta_2 I_i t_i}{q_i}].$$ 5.1.6

Where in addition to the terms previously defined,

Θ_1 = The proportion of the firm's *production* (including manufacturing, selling and administrative) costs that must be allocated to inventory under §471 and/or §263A $[0 \le \Theta_1 \le 1]$. Θ_1 strictly increased when §263A was added to the previously existing §471 [Seago, 1987].

Θ_2 = The proportion of the firm's *holding* costs that must be allocated to inventory under §471 and/or §263A $[0 \le \Theta_2 \le 1]$. Θ_2 strictly increased when §263A was added to the previously existing §471 [Seago, 1987].

Θ_1 is the proportion of *production costs* charged to inventory for tax purposes. Θ_2 is the proportion of *holding* costs charged to inventory for tax purposes. As a result, these two pro-

portions are likely to be different because they come from different functional relationships. Under the simplified method shown in equations 2.1.1, however, the proportions are the same. The equilibrium implications of the simplified method is addressed when the models are analyzed. The Θ in equation 5.1.6 is not exactly the same Θ in equation 2.1.1, but represents the same general concept. The Θ in equation 2.1.1 represents the proportion of mixed costs that are allocated to manufacturing and then to inventory. The Θ in equation 5.1.6 represents the proportion of total costs that are allocated to inventory.

The one-time §481 adjustment (discussed in chapter 1.2) when §263A first became effective equals the increase in production and holding costs allocated to period 0 ending inventory times the present value of the future marginal tax rates (t_p). The §481 adjustment equals:

$$\delta_1\Theta_1[\frac{I_{0-k}t_p}{q_{0-k}}]c_{0-k}(q_{0-k}) + \delta_2\Theta_2[\frac{I_{0-k}t_p}{q_{0-k}}]h_{0-k}(I_{0-k}), \qquad 5.1.7$$

where in addition to the terms previously defined:

δ_j = The increase in the proportion of production (1) and holding (2) costs that must be allocated to inventory (j = 1,2) respectively because of §263A [$0 \leq \delta_j$].

$\Theta_1[\frac{I_{0-k}}{q_{0-k}}]c_{0-k}(q_{0-k})$ = Production costs in inventory from some prior period (0-k), a portion of which must be added to taxable income. If the firm is a FIFO taxpayer, k equals zero. This indicates that the ending year 0 inventory came from year 0 production. If the firm is a LIFO taxpayer, k equals some number greater than zero. This indicates that the ending year 0 inventory came from production in periods prior to year 0.

$\Theta_2[\frac{I_{0-k}}{q_{0-k}}]h_{0-k}(I_{0-k})$ = Inventory holding costs from some prior period (0-k), a portion of which must be added to taxable income.

Insertion of equations 5.1.6 and 5.1.7 into 5.1.4 yields an equation showing the firm's profit when there is no inventory at the end of the two-period life.

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I_1] - c_1(q_1)[1 - t_1] - h_1(I_1)[1 - t_1] -$$

$$c_1(q_1)\left[\frac{\Theta_1 I_1 t_1}{q_1}\right] - h_1(I_1)\left[\frac{\Theta_2 I_1 t_1}{q_1}\right] +$$

$$c_{0-k}(q_{0-k})\left[\frac{\Theta_1 I_{0-k} t_1}{q_{0-k}}\right] + h_{0-k}(I_{0-k})\left[\frac{\Theta_2 I_{0-k} t_1}{q_{0-k}}\right] -$$

$$\delta_1 \Theta_1\left[\frac{I_{0-k} t_p}{q_{0-k}}\right] c_{0-k}(q_{0-k}) - \delta_2 \Theta_2\left[\frac{I_{0-k} t_p}{q_{0-k}}\right] h_{0-k}(I_{0-k}) +$$

$$\frac{1}{1+r}\left[P_2[1 - t_2][q_2 + I_1] - c_2(q_2)[1 - t_2] + c_1(q_1)\left[\frac{\Theta_1 I_1 t_2}{q_1}\right] + h_1(I_1)\left[\frac{\Theta_2 I_1 t_2}{q_1}\right]\right] \qquad 5.1.8$$

Line one of equation 5.1.8 is period one revenue, production costs, and holding costs. Line two describes period one ending inventory of production and holding costs using the FIFO cost flow assumption for tax purposes. Under the FIFO assumption, ending inventory comes from current period production. Line three of the equation describes period one beginning inventory of production and holding costs. Period one beginning inventory comes from the period 0 ending inventory discussed in 5.1.7. Line four of 5.1.8 is the §481 adjustment. Line five of the equation is period two profit. The last two terms of year-two profit are beginning inventory of production and holding cost. There is no ending inventory at the end of the terminal period.

It was argued in chapter 1.3.1 that all costs are not marginal with respect to production, but may be marginal with respect to some other factor such as sales. The sales and production dichotomy is consistent with the §471 and §263A classification of costs as manufacturing (category 1), selling and administrative (category 2), and a mixture of manufacturing, selling and administrative (category 3).

If some costs are functions of quantity produced and some costs are functions of quantity sold, the costs can be thought of as a function of quantity produced and quantity sold. From equation 5.1.3, sales equals quantity produced plus beginning inventory, minus ending inventory. By substitution, costs can be thought of as a function of quantity produced, beginning inventory, and ending inventory. For instance, production costs costs are defined to include all costs to ac-

quire the good and get it to the market, including manufacturing, selling, and administrative items. However, if an item is manufactured, but retained in inventory, certain selling and administrative items are avoided in that period. Therefore, costs that are a function of ending inventory are subtracted from costs in the period the good is produced but not sold. The good is eventually sold, however, and the selling and administrative costs that are a function of beginning inventory are incurred that period and added to costs. Based on the above arguments, the cost function is specified as:

$$c_i(q_i, I_{0-k}, I_i) = c_i(q_i) + c_i(I_{0-k}) - c_i(I_i) \qquad\qquad 5.1.9$$

It is reasonable to believe that the selling and administrative costs avoided in one period because of ending inventory approximately equal the additional selling and administrative costs incurred in a future period because of beginning inventory. Nevertheless, the functions need not be identical (i.e., costs avoided one period are not necessarily equal to the additional costs incurred the next period). In addition, the specification of equation 5.1.9 implicitly assumes that there is no connection between production and inventory holding costs (i.e., $\dfrac{\partial c_i^2(.)}{\partial q_i \partial I} = 0$).[37]

It is argued in chapter 1.3.3 that if a new more inefficient tax policy causes a different combination of input factors to be chosen than were used under a previous act, that combination must be higher-cost, or it would have been chosen previously. The analytical discussions in chapter 4 and appendix B show that §263A is inefficient; therefore, the cost function increases when Θ increases because §263A causes the firm to incur higher costs of *production*. As a result, production costs are a function of units produced, beginning inventory, ending inventory,[38] and Θ as follows:

$$c_i(.) = c_i(q_i, I_{0-k}, I_i, \Theta_j) \qquad\qquad 5.1.10$$

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[37] Increasing marginal production costs are assumed in this dissertation. The negative sign in front of $c_i(I_i)$ means that $\dfrac{\partial c_i(q_i, I_{0-k}, I_i)}{\partial I_i} = - \dfrac{\partial c_i(I_i)}{\partial I_i} < 0$

[38] There is no period two ending inventory.

The inefficiency from §263A also means that *holding* costs increase when Θ increases. Holding costs are a function of inventory held and Θ as follows:[39]

$$h_i(.) = h_i(I_i, \Theta_j)$$ 5.1.11

Substitution of equations 5.1.10 and 5.1.11 into equation 5.1.8 yields,

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I_1] - c_1(q_1, I_{0-k}, I_1, \Theta_j)[1 - t_1] - h_1(I_1, \Theta_j)[1 - t_1] -$$

$$c_1(q_1, I_{0-k}, I_1, \Theta_j)[\frac{\Theta_1 I_1 t_1}{q_1}] - h_1(I_1, \Theta_j)[\frac{\Theta_2 I_1 t_1}{q_1}] +$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k} t_1}{q_{0-k}}] + h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k} t_1}{q_{0-k}}] -$$

$$\delta_1 \Theta_1 [\frac{I_{0-k} t_p}{q_{0-k}}] c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) - \delta_2 \Theta_2 [\frac{I_{0-k} t_p}{q_{0-k}}] h_{0-k}(I_{0-k}) +$$

$$\frac{1}{1+r}[P_2[1 - t_2][q_2 + I_1] - c_2(q_2, I_1, \Theta_j)[1 - t_2] +$$

$$c_1(q_1, I_{0-k}, I_1, \Theta_j)[\frac{\Theta_1 I_1 t_2}{q_1}] + h_1(I_1, \Theta_j)[\frac{\Theta_2 I_1 t_2}{q_1}]]].$$ 5.1.12

In addition, the firm may be either a LIFO or a FIFO taxpayer. If the firm is a FIFO taxpayer, the proportion of ending inventory from current production (ρ) is high, and the proportion of inventory from prior production $(1 - \rho)$ is low. If the firm is a LIFO taxpayer, the proportion of inventory from current production (ρ) is low and the proportion of inventory from prior production $(1 - \rho)$ is high. Under either the FIFO of LIFO cost flow assumption, period one ending inventory (and period two beginning inventory) are:

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[39] There can only be efficiency effects after the act first became anticipated. Therefore, Θ_j is not relevant for period 0 or before for production or holding costs.

$$c_1(q_1, I_{0-k}, I_1, \Theta_j)[\frac{\Theta_1 I_1 t_1}{q_1}]\rho + h_1(I_1, \Theta_j)[\frac{\Theta_2 I_1 t_1}{q_1}]\rho + \qquad\qquad 5.1.13$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k} t_1}{q_{0-k}}][1-\rho] + h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k} t_1}{q_{0-k}}][1-\rho].$$

In addition to the terms previously defined,

ρ = The proportion of inventory from current period production. ρ is close to 1 under the FIFO assumption and close to 0 under the LIFO assumption $[0 \leq \rho \leq 1]$.

$1-\rho$ = The proportion of inventory from prior period production. $(1-\rho)$ is close to 0 under the FIFO assumption and close to 1 under to LIFO assumption.

Substitution of equation 5.1.13 into 5.1.12 yields,

$$\Pi = P_1[1-t_1][q_1 + I_{0-k} - I_1] - c_1(q_1, I_{0-k}, I_1, \Theta_j)[1-t_1] - h_1(I_1, \Theta_j)[1-t_1] -$$

$$c_1(q_1, I_{0-k}, I_1, \Theta_j)[\frac{\Theta_1 I_1 t_1}{q_1}]\rho - h_1(I_1, \Theta_j)[\frac{\Theta_2 I_1 t_1}{q_1}]\rho -$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k} t_1}{q_{0-k}}][1-\rho] - h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k} t_1}{q_{0-k}}][1-\rho] +$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k} t_1}{q_{0-k}}] + h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k} t_1}{q_{0-k}}] -$$

$$\delta_1 \Theta_1[\frac{I_{0-k} t_p}{q_{0-k}}]c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) - \delta_2 \Theta_2[\frac{I_{0-k} t_p}{q_{0-k}}]h_{0-k}(I_{0-k}) +$$

$$\frac{1}{1+r}[P_2[1-t_2][q_2 + I_1] - c_2(q_2, I_1, \Theta_j)[1-t_2] +$$

$$c_1(q_1, I_{0-k}, I_1, \Theta_j)[\frac{\Theta_1 I_1 t_2}{q_1}]\rho + h_1(I_1, \Theta_j)[\frac{\Theta_2 I_1 t_2}{q_1}]\rho +$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k} t_2}{q_{0-k}}][1-\rho] + h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k} t_2}{q_{0-k}}][1-\rho]] \quad 5.1.14$$

The first line of equation 5.1.14 is revenue, production cost and holding cost for period one. Lines two and three are the proportions of ending period one inventory from current production and prior production respectively. Line four is beginning inventory from prior period production. Line five is the §481 adjustment. Line six is revenue and production cost from period 2 (there is no holding cost because there is no ending inventory). Lines seven and eight are the proportions of beginning inventory from period one and prior to period one production respectively.

By algebraic manipulation and simplification equation 5.1.14 becomes:

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I_1] - c_1(q_1, I_{0-k}, I_1, \Theta_j)[1 - t_1] - h_1(I_1, \Theta_j)[1 - t_1] -$$

$$c_1(q_1, I_{0-k}, I_1, \Theta_j)[\frac{\Theta_1 I_1}{q_1}]\rho[t_1 - \frac{t_2}{1+r}] - h_1(I_1, \Theta_j)[\frac{\Theta_2 I_1}{q_1}]\rho[t_1 - \frac{t_2}{1+r}] +$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k}}{q_{0-k}}][t_1 - [1 - \rho]t_1 + \frac{t_2[1 - \rho]}{1+r}] +$$

$$h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k}}{q_{0-k}}][t_1 - [1 - \rho]t_1 + \frac{t_2[1 - \rho]}{1+r}] -$$

$$\delta_1 \Theta_1[\frac{I_{0-k} t_p}{q_{0-k}}]c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) - \delta_2 \Theta_2[\frac{I_{0-k} t_p}{q_{0-k}}]h_{0-k}(I_{0-k}) +$$

$$\frac{1}{1+r}[P_2[1 - t_2][q_2 + I_1] - c_2(q_2, I_1, \Theta_j)[1 - t_2]] \qquad 5.1.15$$

It is demonstrated in chapter 1.1.2 that the change in production and inventory holding depends upon the relative increases in production and holding costs in periods one and two. It is therefore useful to separate production and holding costs into separate components. Total holding costs of inventory can be thought of as the pure economic holding cost plus the costs imposed by the deferral of tax deductions for inventory under §471 and §263A. Pure economic holding cost is the last term in line one of equation 5.1.15. The costs imposed by the deferral of tax deductions for inventory are shown in lines two, three, and four of 5.1.15. Chapter 2.1 points out that no in-

ventory capitalization is required if no inventory is held. By addition and rearrangement of the terms just described as total holding cost:

$$H(I_{o-k}, I_i, q_{0-k}, q_i, \Theta_j, t_i, r, \rho) =$$

$$h_1(I_1, \Theta_j)[1 - t_1] + \frac{I_1\rho}{q_1}[t_1 - \frac{t_2}{1+r}][\Theta_1 c_1(q_1, I_{0-k}, I_1, \Theta_j) + \Theta_2 h_1(I_1, \Theta_j)] -$$

$$\frac{I_{0-k}\rho}{q_{0-k}}[\rho t_1 + \frac{t_2[1-\rho]}{1+r}][\Theta_1 c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) + \Theta_2 h_{0-k}(I_{0-k})] \qquad 5.1.16$$

5.2 Method of Analysis of the Output Model

By substitution of equation 5.1.16 into 5.1.15 and rearrangement, this firm can be modeled as:[40]

$$\Pi = \quad P_1[1 - t_1][q_1 + I_{0-k} - I] + [\frac{1}{1+r}]P_2[1 - t_2][q_2 + I] -$$

$$c_1(q_1, I_{0-k}, I, \Theta_j)[1 - t_1] - [\frac{1}{1+r}]c_2(q_2, I, \Theta_j)[1 - t_2] -$$

$$\delta_1\Theta_1[\frac{I_{0-k}t_p}{q_{0-k}}]c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) - \delta_2\Theta_2[\frac{I_{0-k}t_p}{q_{0-k}}]h_{0-k}(I_{0-k}) -$$

$$H(I_{0-k}, I, q_{0-k}, q_i, \Theta_j, t_1, r, \rho) \qquad 5.2.1$$

---

[40] I_i is changed to I because inventory is a choice variable only in period one of this model.

First and second order conditions of this profit maximization model and the comparative statics results are computed in appendix C. The first order conditions with respect to the choice variables of production in period one, production in period two, and inventory holding are functions of the general form:[41]

$$F_i(q_1, q_2, I_1, \Theta_1, \Theta_2, t_i, r, \rho) = 0 \qquad\qquad 5.2.2$$

$F_i(q_1, q_2, I_1, \Theta_1, \Theta_2, t_i, r, \rho) = 0$ is simply interpreted as some function of $q_1, q_2, I_1, \Theta_1, \Theta_2, t_i, r, \rho$. The simultaneous equation version of the implicit function theorem cited in Chiang [1984, p204-14] shows that if functions in the form of equation 5.2.2 have continuous partial derivatives with respect to all variables in the function, the result can be solved mathematically.[42] The profit equation is assumed to be twice differentiable in this research and as a result:

$$q_1 = \frac{\partial F_1(.)}{\partial q_1} = f_1(\Theta_1, \Theta_2, t_i, r, \rho) \qquad\qquad 5.2.3$$

$$q_2 = \frac{\partial F_2(.)}{\partial q_2} = f_2(\Theta_1, \Theta_2, t_i, r, \rho) \qquad\qquad 5.2.4$$

$$I = \frac{\partial F_3(.)}{\partial I} = f_3(\Theta_1, \Theta_2, t_i, r, \rho) \qquad\qquad 5.2.5$$

Θ_1 and Θ_2 represent the proportion of production and holding costs capitalized and therefore deferred for tax purposes under §471 and §263A. As was previously argued, an increase in these proportions increases production and holding costs. One might expect production and inventory holding to decrease as production and inventory holding costs [i.e., Θ_1 and Θ_2] increase because of

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[41] One or more of the terms may have a zero coefficient.

[42] More precise language requires that the determinant of the Jacobian be non-zero. A Jacobian is simply a matrix of all partial derivatives of a system of equations, arranged in a particular systematic fashion [Chiang, 1984, p.184]. Cramer's rule is used in carrying out the analysis of this exercise and the Jacobian is the denominator of the expression. If the denominator of an expression is zero, the result is undefined and thus "cannot be solved mathematically". Therefore, the Jacobian must be non-zero. Because the third principal minor of the three by three matrix of second order conditions must be less than 0 for a profit maximizer [Chiang, 1984, p.336], the Jacobian determinant is nonzero.

the §263A increase. If the increase in production and inventory holding cost caused by uniform capitalization causes production and inventory holding to decrease, the result is stated mathematically as:

$$\frac{\partial q_1}{\partial \Theta_i} < 0 \ , \quad \frac{\partial q_2}{\partial \Theta_i} < 0 \ , \quad \text{and} \ \frac{\partial I}{\partial \Theta_i} < 0 \qquad\qquad 5.2.6$$

Equation 5.2.6 mathematically restates proposition 3 [§263A leads to a decrease in the quantity of inventory held] and proposition 4 [§263A leads to a decrease in output] in chapter 3.0. If inventory holding and/or production decreases with respect to increases in uniform capitalization allocation rules, the derivatives will be negative. If inventory holding and/or production increases with respect to increases in uniform capitalization allocation rules, the derivatives will be positive.

Section 263A requires capitalization of additional production and inventory holding costs beyond those required under §471. It is not clear whether this section causes a larger increase in the capitalization of production cost in the first period, a larger increase in the capitalization of production cost in second period, or equal increases in the capitalization of production cost each period. As argued in chapter 1.1.2, when production cost increases more in the first period than in the second period, present production and inventory holding decline, but future production is ambiguous because of the shift in production from period one to period two. An increase in holding cost is equivalent to an increase in period two production cost and decreases or reverses the shift of production from the future to the present and decreases or reverses the increase in inventory because of the shift in production cost. If production cost increases more in the second period than in the first period, future production and present inventory holding decline, but present production is ambiguous because of the transfer of future production to the present. An increase in holding cost is equivalent to an increase in period two production cost and adds to the shift of production from period one to period two and adds to the inventory decline.

5.3 Implementation of §263A

Chapter 1.2 explains that §263A increased the carrying value of inventory for tax purposes and that this increase in carrying value increases the amount of taxes currently paid. Section 263A could have been implemented in one of three ways. The provisions of §263A could have been implemented retroactively only on existing stocks of inventory quantity (the catch-up approach) as of some effective date, the provisions could have been implemented only on additions to inventory (the cut-off approach), or the provisions could have been implemented on existing stocks and additions to inventory (the comprehensive approach).[43] Congress chose to use the comprehensive approach that includes both the cut-off and the catch-up inventory accounting adjustment under §481 [Committee on Ways and Means, 1986]. Intuitively, the catch-up adjustment does not appear to distort future production or inventory holding decisions, but inventory accounting rules for tax purposes could have some continuing impact. This is because the company is carrying inventory at a higher value for tax purposes than it otherwise would have carried and production and inventory holding decisions might be affected by the adjustment. Based upon further analysis, the §481 catch-up adjustment is a lump-sum tax and should have no impact on production and inventory holding because it was levied retroactively on inventories held before the act was adopted.

The inventory subject to the catch-up adjustment will eventually be sold. If the producer uses FIFO, the inventory including the §481 adjustment is assumed to be sold and the cost deducted for tax purposes in the period §263A became effective. If the producer uses LIFO, the inventory is assumed to be sold and the cost deducted for tax purposes in a later period. The difference in the FIFO and the LIFO methods is the difference in the present value of the tax deduction for the inventory held when uniform capitalization became effective. One might argue that taxpayer behavior is different under the alternate systems because the present value of the tax deduction for the §481

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[43] The catch-up provision was necessary if the inventory for a LIFO taxpayer was to be retroactively adjusted because ending inventory for a LIFO taxpayer comes from production in some prior period and is carried at that old value until sold, unless it is adjusted. The catch-up provision was not necessary for a FIFO taxpayer because ending inventory comes from current period production that is subject to the new cut-off rules.

adjustment is larger under FIFO than under LIFO. The §481 adjustment is lump-sum, however, and does not affect future production and inventory holding decisions. As a result, the LIFO/FIFO choice also has no affect on future production and inventory holding decisions.

It was argued in the preceding paragraphs that the §481 adjustment required under §263A and the LIFO/FIFO choice should have no distorting effect on future production and inventory holding decisions. Equation 5.2.1 implicitly models the comprehensive approach (catch-up plus cut-off) because it shows the effect of the §481 adjustment and the effect on future inventory increases of §263A cost capitalization rules. The comprehensive model (equation 5.2.1) is compared to the cut-off model (equation 5.2.1 without the §481 adjustment) to determine that the §481 catch-up adjustment has no impact on future inventory holding and production decisions. This analysis will answer two questions:

1. Does the §481 adjustment affect future production and inventory holding decisions (proposition 5)?

2. Is any impact of the §481 adjustment different if the taxpayer chooses FIFO as opposed to LIFO (proposition 6)?

In more mathematical terms, the §481 adjustment affects future production and inventory holding decisions if:

Comprehensive Approach		Cut-Off Approach	
$\dfrac{\partial q_1}{\partial \Theta_j}$	$\neq$	$\dfrac{\partial q_1}{\partial \Theta_j}$	
$\dfrac{\partial I_1}{\partial \Theta_j}$	$\neq$	$\dfrac{\partial I_1}{\partial \Theta_j}$	
$\dfrac{\partial q_2}{\partial \Theta_j}$	$\neq$	$\dfrac{\partial q_2}{\partial \Theta_j}$	5.3.1

The §481 adjustment is modeled in equation 5.1.15 with the δ parameter, where δ is defined to be the increase in the proportion of costs allocated to beginning inventory under §263A. If δ is in the final solution for $\frac{\partial q_1}{\partial \Theta_j}$, $\frac{\partial I_1}{\partial \Theta_j}$, and $\frac{\partial q_2}{\partial \Theta_j}$, then the §481 adjustment affects future production and/or inventory holding decisions. If δ is not in the final solutions, the §481 adjustment has no affect on future production and/or inventory holding decisions.

The §481 adjustment has a different impact if the taxpayer chooses FIFO as opposed to LIFO if:

<div align="center">

FIFO   **LIFO**

$$\frac{\partial q_1}{\partial \Theta_j} \quad \neq \quad \frac{\partial q_1}{\partial \Theta_j}$$

$$\frac{\partial I_1}{\partial \Theta_j} \quad \neq \quad \frac{\partial I_1}{\partial \Theta_j}$$

$$\frac{\partial q_2}{\partial \Theta_j} \quad \neq \quad \frac{\partial q_2}{\partial \Theta_j} \qquad 5.3.2$$

</div>

The LIFO/FIFO choice is modeled in equation 5.1.15 with the ρ parameter. If the §481 adjustment impacts future production and inventory holding decisions and, if ρ is in the solutions, the LIFO/FIFO choice changes the effects of the §481 adjustment.

Equation 5.3.1 mathematically restates proposition 5 [the §481 adjustment has no impact on future inventory holding and production and production decisions] from chapter 3.0. Equation 5.3.2 mathematically restates proposition 6 [any impact of the §481 adjustment is no different if the taxpayer chooses LIFO as opposed to FIFO for tax accounting purposes] from chapter 3.0.

5.4   *Validation of the Output Model*

General approaches to validating analytic models were discussed in chapter 4.4. To the extent that the model developed in equation 4.2.3 is valid, equation 5.2.1 is valid because the output problem is the dual to the input problem [Silverberg, 1978, p.309]. In this case, a model that explains how production and inventory holding change when tax law changes is first developed. Then, well-known economics theory and techniques are used to examine the behavioral effects of the change. This seems to validate the output model.

A behavioral model of §471 and §263A can be derived from the well known single period profit-maximizing model [equation 5.1.1] from the economics literature [Chiang, 1984, p.247]. A number of elements are added to the model to capture the economic rationale for holding inventory. These elements include a second period [5.1.2], the presence of inventory between periods one and two [5.1.3, 5.1.4], the trade-off of increasing marginal production and holding costs [5.1.5], and the form of the functions involved [5.1.9 - 5.1.11]. The inventory rules imposed by §471 and §263A are then added to the two period model [5.1.6 - 5.1.8, 5.1.12 - 5.2.1]. By deductive reasoning, (1) if the beginning model is valid, (2) the changes to the model that explain the rationale for holding inventory are valid, and (2) the modeling of §471 and §263A are valid, the final model is valid.

The final results are examined for reasonableness and for sensitivity to underlying assumptions. The analytic proof is dependent upon the mathematical assumption that cost functions can be differentiated. The emphasis in this research is on the assumptions about the relationships of marginal cost to average cost, production cost to holding cost, and the assertion that marginal production costs are increasing. The economic intuition is dependent upon the assumptions about the relationships of marginal cost to average cost, production cost to holding cost, and the assertion that marginal production costs are increasing. The lack of differentiability is a mathematical complication that is a problem for tractability, but not for economic substance.

Another test for validity is a sensitivity analysis of extreme values of the parameters of the model brought about by the tax act $[0 \leq \Theta_j, t_i, r, \rho \leq 1]$ and $[0 \leq \delta_j]$ that might be manipulated. The sensitivity of the model to high values of the parameters is not particularly interesting, but when the low extreme values are substituted, the results simplify and sometimes converge toward the original two period model. This can be done based on equation 5.1.15 as follows:

1.   If there is no §481 adjustment $[\delta_j = 0]$ then equation 5.1.15 becomes:

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I_1] - c_1(q_1, I_{0-k}, I_1, \Theta_j)[1 - t_1] - h_1(I_1, \Theta_j)[1 - t_1] -$$

$$c_1(q_1, I_{0-k}, I_1, \Theta_j)[\frac{\Theta_1 I_1}{q_1}]\rho[t_1 - \frac{t_2}{1+r}] - h_1(I_1, \Theta_j)[\frac{\Theta_2 I_1}{q_1}]\rho[t_1 - \frac{t_2}{1+r}] +$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k}}{q_{0-k}}][t_1 - [1 - \rho]t_1 + \frac{t_2[1 - \rho]}{1+r}] +$$

$$h_{0-k}(I_{0-k,})[\frac{\Theta_2 I_{0-k}}{q_{0-k}}][t_1 - [1 - \rho]t_1 + \frac{t_2[1 - \rho]}{1+r}] +$$

$$\frac{1}{1+r}[P_2[1 - t_2][q_2 + I_1] - c_2(q_2, I_1, \Theta_j)[1 - t_2]] \qquad\qquad 5.4.1$$

Equation 5.4.1 adds validity to equation 5.1.15 because when there is no §481 lump-sum adjustment required, only the lump-sum adjustment drops out of the model.

2.   If there is no tax $[t_i = 0]$ then equation 5.1.15 becomes:

$$\Pi = P_1[q_1 + I_{0-k} - I_1] - c_1(q_1, I_{0-k}, I_1, \Theta_j) - h_1(I_1, \Theta_j) +$$

$$\frac{1}{1+r}[P_2[q_2 + I_1] - c_2(q_2, I_1, \Theta_j)] \qquad\qquad 5.4.2$$

Equation 5.4.2 adds validity to equation 5.1.15 because when there is no tax, the more complicated model reduces to a simple two-period model.

3.   If the discount rate is zero $[r = 0]$ then equation 5.1.15 becomes:

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I_1] - c_1(q_1, I_{0-k}, I_1, \Theta_j)[1 - t_1] - h_1(I_1, \Theta_j)[1 - t_1] -$$

$$c_1(q_1, I_{0-k}, I_1, \Theta_j)[\frac{\Theta_1 I_1}{q_1}]\rho[t_1 - t_2] - h_1(I_1, \Theta_j)[\frac{\Theta_2 I_1}{q_1}]\rho[t_1 - t_2] +$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k}}{q_{0-k}}][t_1 - [1 - \rho]t_1 + t_2[1 - \rho]] +$$

$$h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k}}{q_{0-k}}][t_1 - [1 - \rho]t_1 + t_2[1 - \rho]] -$$

$$\delta_1\Theta_1[\frac{I_{0-k}t_\rho}{q_{0-k}}]c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) - \delta_2\Theta_2[\frac{I_{0-k}t_\rho}{q_{0-k}}]h_{0-k}(I_{0-k}) +$$

$$[P_2[1 - t_2][q_2 + I_1] - c_2(q_2, I_1, \Theta_j)[1 - t_2]]$$ 5.4.3

Equation 5.4.3 adds validity to equation 5.1.15 because when the discount rate is zero, the model does not fundamentally change.   There may be a change in optimal production and inventory holding, but the model is about the same as equation 5.1.15.

4.   If the discount rate is zero $[r = 0]$ and the tax rates for the two periods are equal $[t_1 = t_2]$, then equation 5.1.15 becomes:

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I_1] - c_1(q_1, I_{0-k}, I_1, \Theta_j)[1 - t_1] - h_1(I_1, \Theta_j)[1 - t_1] -$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k}}{q_{0-k}}][t_1 - [1 - \rho]t_1 + t_2[1 - \rho]] +$$

$$h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k}}{q_{0-k}}][t_1 - [1 - \rho]t_1 + t_2[1 - \rho]] -$$

$$\delta_1\Theta_1[\frac{I_{0-k}t_\rho}{q_{0-k}}]c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) - \delta_2\Theta_2[\frac{I_{0-k}t_\rho}{q_{0-k}}]h_{0-k}(I_{0-k}) +$$

$$[P_2[1 - t_2][q_2 + I_1] - c_2(q_2, I_1, \Theta_j)[1 - t_2]] \qquad 5.4.4$$

Equation 5.4.4 adds validity to equation 5.1.15 because when the discount rate is zero and the tax rates for the two periods are equal, the tax deferral costs disappear. There may be a change in optimal production and inventory holding, but the model is similar to 5.1.15.

5. If the firm uses the FIFO cost flow assumption for tax purposes, $[\rho = 1]$ and $[1 - \rho = 0]$, then equation 5.1.15 becomes:

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I_1] - c_1(q_1, I_{0-k}, I_1, \Theta_j)[1 - t_1] - h_1(I_1, \Theta_j)[1 - t_1] -$$

$$c_1(q_1, I_{0-k}, I_1, \Theta_j)[\frac{\Theta_1 I_1}{q_1}][t_1 - \frac{t_2}{1+r}] - h_1(I_1, \Theta_j)[\frac{\Theta_2 I_1}{q_1}][t_1 - \frac{t_2}{1+r}] +$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k}}{q_{0-k}}][t_1] +$$

$$h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k}}{q_{0-k}}][t_1] -$$

$$\delta_1\Theta_1[\frac{I_{0-k}t_\rho}{q_{0-k}}]c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) - \delta_2\Theta_2[\frac{I_{0-k}t_\rho}{q_{0-k}}]h_{0-k}(I_{0-k}) +$$

$$\frac{1}{1+r}[P_2[1 - t_2][q_2 + I_1] - c_2(q_2, I_1, \Theta_j)[1 - t_2]] \qquad 5.4.5$$

Equation 5.4.5 adds validity to equation 5.1.15 because it demonstrates that the model expenses all beginning inventory under the FIFO assumption.

6.   If the firm uses the LIFO cost flow assumption for tax purposes, $[\rho = 0]$ and $[1 - \rho = 1]$ and does not liquidate any inventory layers, equation 5.1.15 becomes:

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I_1] - c_1(q_1, I_{0-k}, I_1, \Theta_j)[1 - t_1] - h_1(I_1, \Theta_j)[1 - t_1] +$$

$$c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k})[\frac{\Theta_1 I_{0-k}}{q_{0-k}}][\frac{t_2}{1+r}] +$$

$$h_{0-k}(I_{0-k})[\frac{\Theta_2 I_{0-k}}{q_{0-k}}][\frac{t_2}{1+r}] -$$

$$\delta_1\Theta_1[\frac{I_{0-k}t_p}{q_{0-k}}]c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) - \delta_2\Theta_2[\frac{I_{0-k}t_p}{q_{0-k}}]h_{0-k}(I_{0-k}) +$$

$$\frac{1}{1+r}[P_2[1 - t_2][q_2 + I_1] - c_2(q_2, I_1, \Theta_j)[1 - t_2]] \qquad\qquad 5.4.6$$

Equation 5.4.6 adds validity to equation 5.1.15 because it shows that all beginning inventory is retained in ending inventory under the LIFO assumption.

The results of equation 5.1.15 have criterion-related validity [Kerlinger, 1986, p.418] because they predict the changes in production and inventory holding with respect to changes in the tax rules under §263A.

6.0 RESULTS

Section 3.0 set out the research questions and propositions of interest. The propositions and conclusions are as follows:

P_o^1:   Uniform capitalization leads to productive inefficiency (i.e., use of inputs that are not unconstrained cost minimizing).

Section 1.2 shows that §263A has two effects. First, the number of costs that are capitalized for each firm in an industry covered by capitalization requirements is increased. The increase in the number of costs capitalized for each firm in an industry impacts cost comparisons for firms *within* industries. The within industry comparisons are addressed first in this chapter. In addition, the number of industries covered by capitalization is increased. The increase in the number of industries covered impacts cost comparisons for firms *between* industries. The between industry comparisons are addressed after the within industry comparisons.

Within Industry Comparisons

Appendix B.3 shows that §263A cannot increase productively efficient behavior for input decisions made by firms *within* an industry, and results in less productively efficient behavior. Because all firms in competitive markets face the same input prices, it is apparent that productive efficiency occurs if the MRTS [Marginal Rates of Technical Substitution] of all firms equal the price ratio [equation 4.0.2]. Even if the MRTS of all firms do not equal the price ratio, productive efficiency occurs if the MRTS are equal across firms. As more cost allocations are added by the tax law, more allocated terms are added to the MRTS, increasing the probability that the MRTS for at least some firms within an industry have different MRTS.

When more allocated costs were added to the MRTS by §263A, the analysis in appendix B.3 shows that the MRTS for firms cannot be closer to each other, and can only be further from equal. There are five possibilities that must be examined:

1. **Section 471 leads to productively efficient behavior, while §263A leads to productively inefficient behavior** [Equations B.3.1.2, B.3.1.4, B.3.1.7, B.3.1.9, B.3.1.10, B.3.2.1, B.3.2.3]. This case occurs because of the expanded definition of manufacturing cost under §263A.

2. **Section 263 leads to behavior that is more productively inefficient than the behavior §471 leads to** [Equations B.3.1.3, B.3.1.6]. This case also occurs because of the expanded definition of manufacturing cost under §263A.

3. **Sections 471 and §263A lead to equally productive inefficient behavior** [Equations B.3.1.1, B.3.1.8]. This means that §263A has no impact on productive efficiency for these cost comparisons because §471 and §263A lead to equally inefficient behavior since they use the same rules. This case occurs for manufacturing costs as originally defined under §471.

4. **Both §471 and §263A lead to productively efficient behavior** [Equation B.3.1.5, B.3.2.2, B.3.3.1, B.3.3.2, B.3.3.3]. This means that §263A has no impact on productive efficiency for these cost comparisons because both §471 and §263A lead to efficient behavior. This case occurs for selling and administrative costs and service firms that are not covered under §471 or §263A.

5. **Section 263A leads to productively efficient behavior, while §471 leads to productively inefficient behavior.** There are no examples of this case.

Using the criteria of equation 4.0.2, the five cases above show that §263A adds more sources of inefficiency to the tax code [cases 1 and 2], leads to all the productive inefficiencies of §471 [case 3], and cures none of the inefficiencies of §471 [cases 4 and 5]. For example, case 1 shows:

§471   **§263A**

$MRTS_{iu,iu'} =$ $MRTS_{iu,iu'} =$ 6.0.1

$\dfrac{w_{iu}}{w_{iu'}}$ $\dfrac{w_{iu}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{iu}}{[1+r]^n}}{w_{iu'}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{iu'}}{[1+r]^n}}$

Equation 6.0.1 shows that under §471, the $MRTS^M_{ia,iu}$ for all manufacturing firms equal the price ratio. Because all firms in a competitive market face the same prices, productive efficiency must occur. Section 263A, however, leads to $MRTS^M_{ia,iu}$ that differ from the price ratio and, in general, differ across firms. Section 263A leads to productively inefficient behavior unless one assumes that all firms within a particular industry have the same production technology and use the same cost allocation techniques. If all firms within a particular industry have the same production technology and use the same cost allocations techniques, then the allocated terms for all firms would be identical and, as a result, the MRTS under §263A would be equal across firms. This

possibility seems unrealistic given the different kinds of markets that are available within each industry. For instance, Bethlehem Steel and Nike are both manufacturers, but it is unlikely that they have the same production technology or use the same cost allocation techniques.

In short, the increased number of costs required to be capitalized under §263A by firms already subject to capitalization requirements under §471 leads to productively inefficient behavior. Service firms are not currently covered by §263A. Equations B.3.3.1 - B.3.3.3 show that service firms make productively efficient input decisions because all service firms have equal MRTS. Extending the §263A rules to service firms would make the economy more productively inefficient because service firms then would have input choices distorted by tax rules (in addition to the distortions already imposed on manufacturers and retailers). The formal analysis would be intuitively identical to the previous analysis done in this chapter.

Between Industry Comparisons

The analysis in appendix B.4 shows that §263A cannot increase productively efficient behavior for input decisions made by firms *between* industries (as defined by the tax code), and results in less productively efficient behavior.

Because all firms in competitive markets face the same input prices, equation 4.0.2 shows that productive efficiency occurs if all the MRTS of firms between all industries equal the price ratio. If the MRTS of all firms do not equal the price ratio, productive efficiency occurs only if the MRTS are equal for all firms. As more cost allocations are added by the tax law, more allocated terms are added to the MRTS, thereby increasing the probability that the MRTS for at least some firms within an industry have different MRTS.

The analysis in appendix B.4 shows that when more allocated costs are added to the MRTS by §263A, the MRTS for all firms cannot be more nearly equal to each other, and will likely be further from equal. There are four general cases that must be addressed to illustrate that §263A leads to more productively inefficient behavior than §471 for input decisions made by firms *between* industries.

1. **Section 471 leads to productively efficient behavior for input decisions made by firms *between* industries, while §263A leads to productively inefficient behavior for input decisions made by firms *between* industries.:** [Equations B.4.1.1, B.4.1.3, B.4.2.1, B.4.2.3]. This case occurs because mixed costs and selling and administrative costs are not covered under §471, but are not covered under §263A.

2. **Both sections 471 and 263A lead to productively efficient behavior for input decisions made by firms *between* industries.:** [Equations B.4.1.2, B.4.2.2]. This case occurs because selling and administrative costs are not covered under §471 or §263A.

3. **Section 471 leads to productively inefficient behavior for input decisions made by firms *between* industries, while §263A leads to productively efficient behavior for input decisions made by firms *between* industries.:** There are no examples of this case.

4. **Both sections 471 and 263A lead to productively inefficient behavior for input decisions made by firms *between* industries.:** There are no examples of this case.

Using the criteria of equation 4.0.2, the four cases above show that §263A unambiguously adds more sources of inefficiency to the tax code. For example, case 1 shows:

$$§471$$

Manufacturers: **Retailers:**   **Services**

$MRTS_{j,k} =$ $MRTS_{j,k} =$ $MRTS_{j,k} =$ 6.0.2

$\dfrac{w_j}{w_k}$ $\dfrac{w_j}{w_k}$ $\dfrac{w_j}{w_k}$

<center>§263A</center>

Manufacturers:	**Retailers:**	**Services**
$MRTS_{j,k} =$	$MRTS_{j,k} =$	$MRTS_{j,k} =$ 6.0.3

$$\frac{w_j[1 - t[1 - \theta_j[\frac{[1 + r]^n - 1}{[1 + r]^n}]]] - \frac{t\theta_j f_{iu}}{[1 + r]^n}}{w_k[1 - t]}$$

$$\frac{w_j[1 - t[1 - \theta_j[\frac{[1 + r]^n - 1}{[1 + r]^n}]]] - \frac{t\theta_j f_{iu}}{[1 + r]^n}}{w_k[1 - t]}$$

$$\frac{w_j}{w_k}$$

Equation 6.0.2 shows that under §471, the $MRTS_{j,k}^M$ for all manufacturing, retailing, and service firms equals the price ratio. Because all firms in a competitive market face the same prices, productive efficiency must occur. Equation 6.0.3 shows that under §263A, the $MRTS_{j,k}^M$ for manufacturing, retailing, and service firms do not equal each other. Section 263A leads to less productively efficient behavior because the MRTS of all manufacturing, retailing, and service firms were equal under §471, but do not equal under §263A.

In short, this research demonstrates that the increased number of industries subject to the rules of §263A leads to productively inefficient behavior. Service firms are not currently covered by §263A. Equations B.4.2.1 and B.4.2.3 show that manufacturing, retailing, and service firms make productively inefficient input decisions between firms because the firms have different MRTS. Extending the §263A rules to service firms could have no negative impact on productive efficiency (because the input choices are already distorted) nor could it have a positive impact on productive efficiency unless one makes the very unlikely assumption that all firms in all markets in all industries (Bethlehem Steel, Wal Mart, and Coopers & Lybrand, CPA's) have the same production technology and use the same cost allocation techniques. The formal analysis of extending §263A to service firms would be intuitively identical to the previous analysis in this chapter.

Conclusions

Because the increased number of costs capitalized and the increased number of firms covered both lead to inefficient behavior, §263A strictly leads to less productively efficient behavior than §471. The intuition for this result is that §263A strictly increases the number of cost allocations required for tax purposes, and therefore increases the number of marginal rates of technical substitution that are not equal across firms within industries and across industries. Increasing the number of marginal rates of technical substitution that are not equal to each other within industries means that some costs (i.e., manufacturing and mixed items) are more expensive after-tax than other costs (selling items). As a result, §263A induces firms within an industry to use higher-cost input combinations than does §471, or those combinations would have been used under §471.

Increasing the number of marginal rates of technical substitution that are not equal between industries means that some industries (i.e., manufacturing and retailing) operate at higher after-tax costs than other industries (service). As a result, §263A induces firms to change industries and earn less profit after §263A in the new industry than they earned under §471 in the old industry (or else the firm would have been in the new industry under §471). Extending the §263A rules to service firms would therefore increase the inefficiencies in the system by forcing more firms into inefficient behavior.

In summary, §263A increased the uniformity of the cost allocations, but these allocations were uniformly bad. Section 471 leads to productively inefficient behavior, and §263A increases the inefficiency. Firms are worse off under §263A than they were under §471 because they produce at higher cost and lower profits. Society is worse off because §263A results in more resource use and therefore waste resources.

Intuitively, one might argue that subjecting all firms to the same distortions leads to productively efficient behavior because all firms have the same or close to the same distortions. If all the firms have the same distortions, then all the firms have the same MRTS and productive efficiency occurs. This possibility never materialized in the relevant comparisons.

Effect of Removing Sections 471 and 263A

If there were no allocations required in equations 6.0.1 - 6.0.3, $\theta = 0$ and all the MRTS equal the price ratio and equal each other since all firms face the same input prices in a competitive market. The result of the elimination of §471 and §263A is productive efficiency. The lost revenue could be recouped by a lump-sum adjustment on each taxpayer equal to the amount of inventory cost previously capitalized. The net result is that the economy operates efficiently at a lower cost, inputs are not wasted, and tax revenue is retained. Tax revenues lost from increases in inventory held in the future will be partially or fully offset by increases in real economic income that result from efficiency gains.

P_o^2:   Uniform capitalization leads to allocative inefficiency (i.e., production of products that are not unconstrained profit maximizing).

The analysis in appendix B.1 shows that §471 and §263A both lead to allocatively efficient production of outputs. Because there are no tax distortion effects on consumer or producer prices, §471 and §263A lead to allocatively efficient behavior across code sections and across firms. The intuition of this result is that inputs are treated differently by §471 and §263A, but there is no difference in the taxation of outputs. Therefore, there are no distortions between firm and consumer prices.

While it is true that uniform capitalization has an equilibrium effect on outputs because of cost distortions, the effect is reflected in the price of the goods and thus consumers make different (than before §263A), but utility-maximizing, decisions under §263A. The difference in the optimal combination of goods consumed and goods purchased results from productive inefficiency of inputs, not allocative inefficiency of outputs.

The conclusions of this research are the opposite of the conclusions proposed by Evans [1989]. He argued that §263A surrogated for changes in economic inventory values and moved the tax inventory accounting rules toward the Haig-Simon economic measurement of inventory costs. To put the Evans analysis into more precise economic terms, the "better" valuation of inventory

leads firms to make profit-maximizing output decisions within and between industries, which leads to allocatively efficient behavior. The results of this research demonstrate that since neither §471 nor §263A have any distorting effects on outputs, and consumers make utility-maximizing decisions that are not distorted by taxes, producers make profit-maximizing choices that are not distorted by taxes. Because the sections relate to inputs and not outputs, §263A is not an improvement in allocative efficiency over §471 - the sections have nothing to do with allocative efficiency. As a result, producers display allocatively efficient behavior under both §471 and §263A.

There are a number of problems with the Evans analysis. First, the Haig-Simon definition of income is only appropriate if it leads to more efficient economic behavior. The Haig-Simon definition does not include a measure of efficiency, nor does it define which type of efficiency is enhanced. Therefore, Haig-Simon is an inadequate evaluation standard. Second, Evans does not distinguish between productive and allocative efficiency. The Haig-Simon definition appears to lead to profit-maximizing output choices. This is an allocative efficiency issue. Evans, however, framed his arguments in the context of inputs, which impact productive efficiency. Even if the Haig-Simon definition were an appropriate standard for allocative efficiency, this is a productive efficiency problem. Third, Evans implicitly assumes that uniformity and an increased number of input cost tax allocations are identically the same and proxy for fair market output value of inventory. Section 263A, however, achieves uniformity by requiring a larger number of cost allocations. The increased number of allocations that do not proxy for marginal input cost (not the uniformity) create more productive inefficiency.

This research improves upon the Evans analysis by mathematically modeling §471 and §263A and comparing the results to established criteria for productive and allocative efficiency. Allocative efficiency occurs under both §471 and §263A, but increased productive inefficiency occurs under §263A.

In short, Evans argued that §263A increases the allocative efficiency of a system that was already allocatively efficient. Section 263A actually reduces productive efficiency, which will be reflected in higher prices. Given the prices, consumers and producers will make allocatively efficient

decisions. It is true that consumers and producers make different and less optimal choices under §263A, but the inefficiency results from productive inefficiency, not allocative inefficiency.

The United States transactions-based tax system fundamentally departs from the Haig-Simon definition of true economic income. Although Evans argued that §263A approximates an economic definition of income, this research shows that the additional cost allocations required under §263A make the system less, not more efficient. The loss of efficiency results because the allocations are not marginal with respect to production decisions

P_o^3:   Uniform capitalization leads to changes in the equilibrium quantity of inventory held.

The results in appendix C.3 show that inventory holding decreases when §263A is imposed if the firm uses LIFO for tax purposes and has no current period production in ending inventory [i.e., $\rho = 0$]. This research defines ρ to be the proportion of current production in ending inventory. A very low value for ρ is consistent with the LIFO inventory method because LIFO inventory comes primarily from prior production. Equation C.4.39 shows that ρ equals zero [i.e., there is no current period production in ending inventory] if marginal production cost [with respect to inventory] avoided in period one increases more because of §263A than the sum of the increases of marginal holding cost [with respect to inventory] and marginal period two production cost [with respect to inventory] because of §263A. The discussion following equation C.4.39 shows that the increase in period one marginal production cost [with respect to inventory] because of §263A approximately equals the increase in period two marginal production cost [with respect to inventory] because of §263A. This leaves the increase in marginal holding cost [with respect to inventory] because of §263A which is greater than zero because §263A is inefficient. Therefore the ρ likely equals zero.

The *cost assumption* in C.4.39 is equivalent to using the LIFO inventory *tax assumption* [i.e., ending inventory comes from the earliest available production, primarily beginning inventory] and the *mathematical assumption* that $\rho = 0$ [the proportion of ending inventory from current production is zero]. When $\rho = 0$, many terms disappear and the problem becomes mathematically

tractable. Therefore the *cost, tax,* and *mathematics* assumptions are consistent and complementary. Because §263A is inefficient and inventory holding likely declines, this assumption is not contradicted. If §263A had been efficient, thereby allowing an inventory increase, the assumption would have been contradicted.

The results are consistent with the intuition developed in Chapter 1.1.2 where it is shown that the direction of increase or decrease in inventory is determined by the relationships of the increases in production and holding cost caused by §263A. It is also argued in chapter 1.1.2 that because items produced in periods one and two are substitutes for each other, changes in output in each of the periods depend on the relative increases in production cost between the two periods and the increase in holding cost. The decreases in production each period differ slightly from the original intuition because the effect on total production of the cost increases was not explicitly considered. Because total production must go down when costs increase, it is logical that production each period also decreases, in spite of the fact that the relative cost increases may have some effect on the magnitude of the decreases each period.

The argument in chapter 1.3.1 is that holding lower levels of inventory by manufacturers and retailers appears to be bad per se because service firms were already given preferential treatment under §471 and §263A makes the preference even larger. The original intuition does not apply because firms only hold inventory in this model because it is sometimes cheaper to produce and hold inventory for a period than it is to defer production. As a result, holding more or less inventory is not bad per se, but only results from productive inefficiencies that cause the increase or decrease in inventory holding.

P_o^4:   Uniform capitalization leads to changes in equilibrium output.

The analysis in appendix C.1 shows that production in the first period decreases when §263A is imposed if the firm uses LIFO for tax purposes and retains no current period production in inventory. All current period production costs are charged to expense under the LIFO and no in-

ventory accumulation assumptions. Because §263A is inefficient, costs increase, and production decreases.

The analysis in appendix C.2 shows that production in the second period decreases when §263A is imposed, independent of the inventory method used for tax purposes. This result is logical because in the second period there is no ending inventory and all current period production and holding costs are charged to expense. Because §263A is inefficient, costs increase and quantity decreases. The result reverses if §263A is efficient.

P_δ^5:   The §481 adjustment has no impact on future production and inventory holding decisions.

The §481 adjustment is modeled as δ in equation 5.1.7. This parameter does not appear in the first order conditions of C.1.3 - C.1.5 and C.4.41 - C.4.43. Therefore, the §481 adjustment has no impact on future production and inventory holding decisions. This demonstrates that the §481 lump-sum adjustment is truly efficient because it does not distort future decisions.

The argument in chapter 5.3 is that although the §481 adjustment is a lump-sum tax, future decisions might be affected because the inventory is being carried at a higher tax value because of the §481 adjustment. This research shows that the changes in production and inventory holding depend upon the trade-offs of marginal production and holding costs. As a result, inventory carrying values for tax purposes are not relevant to future production or holding because the §481 adjustment is levied on past, not future, decisions.

P_δ^6:   Any impact of the §481 adjustment is no different if the producer chooses LIFO as opposed to FIFO for tax accounting purposes.

Because the §481 adjustment has no impact on future production and inventory choices, the LIFO or FIFO tax accounting rules have no additional impact on production and inventory holding decisions because of the §481 adjustment.

Based on chapter 5.3, one might argue that future decisions are affected by the LIFO/FIFO choice because the present value of the tax deduction for the §481 adjustment is larger under FIFO than under LIFO. This research supports the intuition that the §481 adjustment is lump-sum and does not affect future production and inventory holding decisions. As a result, the LIFO/FIFO choice can no affect on future production and inventory holding decisions.

7.0 SUMMARY, LIMITATIONS, POLICY IMPLICATIONS AND CONTRIBUTIONS

7.1 Summary

This research contains the development of a mathematical input model of uniform capitalization, performs an analysis of the model, and advances the conclusion that uniform capitalization unambiguously causes productively inefficient behavior. The provisions of §263A that arbitrarily required more costs to be allocated and more industries to be covered created the inefficiency. Treasury II [The White House, p. 202] and Evans [1989] assume that a uniform set of inventory accounting rules leads to increased economic efficiency and that increases in the number of required allocations leads to even greater efficiency. The results show that the rules are uniform, but uniformly bad, because they decrease productive efficiency. Treasury II and Evans therefore advocate a uniformly bad, rather than a uniformly good, system. The uniformity of the system is not the problem. The increased number of cost allocations required is the problem with §263A.

This research also contains the development of a mathematical output model of uniform capitalization, an analysis of the model, and concludes that under LIFO inventory and some rea-

sonable cost assumptions, production unambiguously decreases because the inefficient tax act in-
creases production costs. The effect on inventory holding depends on whether the increases in
marginal production cost [with respect to inventory] avoided in period one caused by §263A dom-
inate the sum of the increases in marginal holding cost [with respect to inventory] and marginal
period two production cost [with respect to inventory] caused by §263A or the reverse. This result
is consistent with the intuition developed in Chapter 1.1.2.

7.2   Limitations

1. This research makes a number of assumptions about firm behavior, market structure,
    and cost behavior, including:

    A. Firms are profit maximizers and markets are perfectly competitive. The assump-
        tion of profit maximization seems reasonable in the business environment. The
        assumption of perfect competition is made to make the mathematics tractable and
        has no affect on the allocative efficiency result because chapter 6.0 argues that §471
        and §263A relate to inputs and not outputs. Section 263A is not an improvement
        in allocative efficiency over §471 - the sections have nothing to do with allocative
        efficiency. As a result, producers display allocatively efficient behavior under both
        §471 and §263A, whether the firm is perfectly competitive, part of an oligopoly,
        or a monopolist.

        The assumption of perfect competition should have no affect on the productive
        efficiency result because chapter 4.0 shows that if there is an optimal distribution
        of income, increases in productive efficiency are desirable in any market structure
        [Diamond and Mirrlees, 1971]. That is, publicly traded firms that are perfectly
        competitive, part of an oligopoly, or monopolists are driven to productive effi-

ciency by profit-maximizing behavior. The logic of this argument is that improvements in productive efficiency allow the firm to decrease the consumption of at least one input without harming the production of any good. The decreased consumption of input(s) may allow the production of more outputs. Surely at least one person is made better off by the decreased use of inputs and potential production of more outputs without making anyone worse off. If this is the case, then improvements in productive efficiency are Pareto improving [Tresch, 1981, p.31].

Friedman discusses research assumptions at length. He distinguishes between assumptions that have practical significance and assumptions that have only technical or analytic significance. Some assumptions may not hold in the strictest sense, but they act *as if* they hold. For instance, few believe that perfect competition actually exists in very many markets. However, industrial organization researchers only have clear evidence that firms earn profits in excess of the competitive return when eight firm concentration ratios are 70% or above. [See Bain, 1951 in Scherer, 1980, p.267-295]. Based on this result, a wide range of markets behave *as if* they are competitive. The assumption of perfect competition has analytic importance, but little practical significance. [See Musgrave, 1981 and Blau, 1980].

B. Firms operate in a partial equilibrium economy. Partial equilibrium analysis implicitly assumes that feedback affects do not exist. When the feedback is small, there is no grave consequence to using partial equilibrium instead of general equilibrium analysis. This is the usual benchmark assumption made for analytic tractability in the early study of public sector problems and provides a frame of reference for later research when the assumptions are relaxed.

C. Accounting, tax, and economic costs are identical except for the provisions of §471 and §263A. This ceteris paribus assumption allows the focus to be placed on the

effects of uniform capitalization without the confounding effects of other tax departures from economic costs. Future research will analyze other cases where tax measurements of cost and economic measures of cost differ.

D. An improvement in productive efficiency is Pareto improving if there are no equity changes. This result strictly holds under very restrictive circumstances, but is logical because improvements in productive efficiency free up resources that someone in the economy can use. This assumption is used in the efficiency analysis.

E. Cost as a function of outputs is differentiable with respect to all choice variables and parameters. This assumption eases mathematical analysis and allows the use of the implicit function theorem. It is quite standard in economic analysis, and has no practical significance.

F. Marginal production cost (with respect to quantity produced and inventory held) and marginal holding cost (with respect to inventory held) are positive, increasing, and differentiable. The first two assumptions are made to economically justify holding inventory. In the model presented, there is no reason to hold inventory if it is just as expensive to produce currently as it is to produce in the future. The assumption of increasing marginal costs is necessary in the short term to keep the firm from growing into a monopoly. Since several firms are observed in most industries, there is evidence that marginal costs are increasing. The differentiability assumption is made to permit mathematical analysis, but is not essential to the qualitative results.

G. Input costs can be conveniently separated into fixed and variable components. This is the standard assumption in accounting models.

H. LIFO inventory is assumed and:

$$
\frac{\partial^2 c_1(.)}{\partial I \partial \Theta_j} [1 - t_1] + \frac{\partial^2 c_2(.)}{\partial I \partial \Theta_j} \frac{[1 - t_2]}{[1 + r]} + \frac{\partial^2 h(.)}{\partial I \partial \Theta_j} [1 - t_1] > 0.
$$

When this cost relationship holds, $\frac{\partial I}{\partial \Theta_j} \leq 0$. That is, inventory holding decreases when the costs capitalized under §263A increase and thus ρ [the proportion of ending inventory from current period production] = 0 under the LIFO inventory method. It is argued in appendix C.3 that the first two terms of the above expression sum to approximately zero because costs avoided one period are incurred the next period. Because §263A leads to productively inefficient behavior, $\frac{\partial^2 h(.)}{\partial I \partial \Theta_j}[1 - t_1] > 0.$, and thus the sum of the terms should be greater than zero.

I. There is no inflation. The prior analysis suggests that inflation has an impact on equilibrium production and inventory holding only if the inflation changes the relationship between the increases in marginal period one and period two production costs and holding costs because of §263A. It seem reasonable to believe that inflation has little or no affect on the increase in marginal costs because of §263A, so this assumption has no impact. Income tax accounting rules that exclude the effects of inflation tend to increase the size of the distortions highlighted here [Feldstein, 1976 and Feldstein and Summers, 1978]. A firm conclusion can be established in further research.

J. Firms have a two-period life. The finite remaining life of any firm can arbitrarily be divided into any number of time periods. The analysis in this research is based on two periods with an implicit prior period where inventory is first accumulated. The two periods are required to examine production and inventory holding choices when capitalization rules are changed in one period and and the same choices in a period where liquidation occurs. This assumption is reasonable and makes mathematical analysis more tractable.

K. Equation 5.1.9 assumes that inventory holding and production costs are separable from each other and $\frac{\partial^2 c_1}{\partial q_1 \partial I_1} = 0$. This mathematical assumption means that marginal production costs do not change when more inventory is added. This seems like a reasonable, although not necessary assumption.

L. The firm is subject to deterministic demand, but has no stock-out, LIFO liquidation costs, or one-time production costs. These assumptions are made to justify holding inventory, simplify the problem, and to permit analysis of inventory holding because of future price changes caused by demand fluctuations. If the firm had stock-out, LIFO liquidation, or one-time production costs, it would have reasons to hold inventory other than the one put forth in this research. It seems reasonable to believe that §263A would have a similar effect on production and inventory holding, independent of the reasons inventory is held.

M. Only domestic production is modeled. Foreign production would allow other alternatives for firms that wish to avoid costs imposed by §263A and make analysis more difficult. If foreign production were allowed, the costs imposed by uniform capitalization could not increase, but it is possible that the foreign production opportunity may be better than the domestic alternatives, partially mitigating the productive inefficiency costs. In any case, foreign production is not a reasonable alternative for many of the firms affected.

The assumptions are made primarily to simplify the problem. After the simple problem is well understood, the assumptions can start to be relaxed.

2. This research does not estimate the magnitude of any equilibrium or efficiency effects. Future research can estimate these magnitudes once the direction and sources of effects is well understood.

3. This research does not unambiguously establish the direction of the change in inventory holding caused by §263A. Empirics may be needed to establish the direction of the change.

7.3 Policy Implications

Treasury II [The White House, p. 202] argued for §263A essentially on the basis of improving equity and efficiency. This research does not directly address the equity issue, but chapter 1.3.1 argues that the types of equity discussed are really not only equity issues (crowd out of low income taxpayers from multi-period activities), but can be thought of as efficiency issues. This is because one might argue that it is not equitable for one taxpayer to pay tax one period and another taxpayer to pay tax the following period on equivalent activities. This is also an efficiency issue because the taxpayers would have different effective tax rates that might distort decisions. This research shows that if the equity and efficiency issues discussed were the goals, the act failed. In contrast to the desired results, the conclusions from this research show that §471 and §263A have no affect on allocatively efficient behavior. Section 471 is, however, productively inefficient and §263A increases the inefficiency. This inefficiency is bad for the firm and bad for society because firms will use more and/or more expensive resources under §263A than they used under §471. Uniform capitalization therefore fails the policy objective of increased efficiency.

There are some who argue that §263A was inserted to raise revenue [Galante and Jacobs, 1987]. This research shows that the §481 catch-up provisions of §263A are efficient because they do not further distort output decisions. Therefore, Congress could have simply implemented §263A retroactively [i.e., the catch-up provisions] and deleted the future provisions [i.e., the cut-off provisions]. This would have allowed Congress to raise revenue without imposing dead weight efficiency losses on the economy and resource waste on society. Because the catch-up provisions are levied on the stock of inventory while the cut-off provisions are levied on the increases in inventory, it seems reasonable to suggest that the catch-up provisions will raise the bulk of the revenue.[44] This

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[44] The catch-up provision for a LIFO taxpayer is necessary because ending inventory comes from production in some prior period and is carried at that old value until sold, unless it is adjusted. The inventory valuation will automatically be adjusted for a FIFO taxpayer because ending inventory comes from current period production that is subject to the new cut-off rules. The point remains, however, that the bulk of the revenue will come from the change in capitalization on existing stocks of inventory, not future increases in inventory.

is especially true because the analysis shows that the cut-off provisions cause inventory stock to decrease.

If Congress wanted to increase economic efficiency, it could have eliminated inventory capitalization rules entirely. If there were no inventory cost allocations required, $\theta = 0$, and all the MRTS equal the price ratios and each other because all firms would face the same input prices in a competitive market. The elimination of §471 and §263A would result in productive efficiency. The lost revenue could be recouped by a lump-sum adjustment on each producer equal to the amount of inventory cost previously capitalized. The net result is that the economy would operate efficiently at a lower cost, inputs would not be wasted, and tax revenue would be retained. Tax revenues lost from increases in inventory held in the future would be partially or fully offset by increases in real economic income that result from efficiency gains.

7.4 Contributions

The contributions of this research to date are:
1. Two sections of tax code are mathematically modeled and are subjected to standard equilibrium and efficiency analysis. This is relatively new to the tax accounting literature.
2. Separate examinations of allocative and productive efficiency show that the separation clears up confusion in prior research.
3. The analytic results described in chapter 6 show that both §471 and §263A lead to allocatively efficient behavior.
4. The analytic results described in chapter 6 show that §263A leads to more productively inefficient behavior than §471.

5. The analytic results described in chapter 6 show that under a LIFO inventory assumption, §263A leads to decreased production. The conditions under which inventory holding is decreased are shown.

6. The analytic results described in chapter 6 show that the §481 adjustment does not impact future production and inventory holding decisions.

7. The analytic results described in chapter 6 show that the LIFO/FIFO decision has no effect of the §481 adjustment.

7.5 Future Research

1. Many assumptions are made in this research to simplify the problem. Now that the simple problem is understood, the assumptions can be relaxed analytically.

2. This research does not estimate the magnitude of any equilibrium or efficiency effects. Empirical research can estimate these magnitudes now that the direction and sources of effects are understood.

3. This research does not unambiguously establish the direction of the change in inventory holding caused by §263A. Empiricical research can establish the direction of the change.

4. This research does not suggest the effects on tax revenue of uniform capitalization. Empirical research can establish the magnitude of the revenue collection and the affect of the catch-up and cut-off adjustments.

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APPENDICES:

Appendix A

Pareto optimality is the usual criterion for public policy analysis and occurs when one person cannot be made better off without making another person worse off. Tresch [1981, p26-37] demonstrates this condition mathematically as:

Max $\quad\quad\quad$ $W[U^h (X_{h, g}, V_{h, f})]$ $\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ A.0.1

Subject to simultaneous clearing of all good and factor markets.

Where:

$\quad\quad$ $W[U^h]$ $\quad\quad\quad$ A function that describes the overall welfare of society at large. [For instance this function could be the sum of the utilities of all members of that society.]

$\quad\quad$ $U^h[X_{hg}, V_{hf}]$ $\quad\quad$ A function that describes the utility [preferences] of an individual (h). This ordering is a function of goods consumed and factors of production provided.

$\quad\quad$ X_{hg} $\quad\quad\quad\quad$ A good consumed by person h.

$\quad\quad$ V_{hf} $\quad\quad\quad\quad$ A factor of production provided by person h such as labor or capital.

Using the notation of Tresch [1981], in competitive markets, Pareto optimality holds when consumptive, allocative, and productive efficiency conditions are simultaneously met *independent of the underlying utility and welfare functions* . Therefore, two societies could have different values

concerning the allocation or resources, employment of labor, etc. and the efficiency conditions still hold[45].

The logic of the Pareto optimal conditions starts from the following basic individual consumer and single firm market equilibrium conditions:

1. Individual A wishes to maximize utility [satisfaction] subject to an income constraint. Within this constraint, A will consume until the marginal utility of that good equals the price of that good $[U'_h = R_h]$. Likewise, $U'_{h'} = R_{h'}$. By simple division:

$$\text{Consumer Equilibrium} \qquad MRS^A_{h,\,h'} \quad = \quad \frac{U'_h}{U'_{h'}} \quad = \quad \frac{R_h}{R_{h'}} \qquad\qquad A.0.2$$

2. Firm M wishes to minimize cost and will continue to use an input until the marginal output created by the additional unit of input equals the price of the input $[H'_L = w_L]$. Likewise, $H'_{L'} = w_{L'} \; \forall \; L = i,j,k$. By simple division:

$$\text{Cost Minimization} \qquad MRTS^M_{L,L'} \quad = \quad \frac{H'_{i,\,j,\,k}}{H'_{i,\,j,\,k}} \quad = \quad \frac{w_L}{w_{L'}} \qquad\qquad A.0.3$$

3. Firm M wishes to maximize profit and will therefore produce until the marginal cost of the good equals the price of the good $[G'_h = R_h]$. Likewise, $G'_{h'} = R_{h'}$. By simple division:

$$\text{Profit Maximization} \qquad MRPT^M_{h,\,h'} \quad = \quad \frac{G'_h}{G'_{h'}} \quad = \quad \frac{R_h}{R_{h'}} \qquad\qquad A.0.4$$

Where:

$MRS^A_{h,\,h'}$ = Marginal Rate of Substitution for person A between goods h and h'. If a consumer is maximizing utility, the MRS is the maximum rate that person A can

---

[45] That is, the competitive market system generates the full set of Pareto Optimal conditions, but is neutral with respect to the distribution of resources. If society cares about the distribution of resources, a governmental body can maximize welfare by moving along an efficient frontier of individual utility combinations until maximum welfare is obtained. Thus the government imposes interpersonal equity conditions, while maintaining efficiency [Tresch, p37]. The government is required because individual consumers would not make the required choices since some consumers are unwilling to give up resources.

exchange product h for product h', while maintaining the same utility (i.e., level of satisfaction) [Rosen, 1985, p. 587].

$\text{MRTS}^{M}_{L,\,L'} =$ Marginal Rate of Technical Substitution for firm M between any inputs L and L' for all ($\forall$) $L = i,j,k$ (in all combinations of i,j,k). i,j,k are defined to be manufacturing costs, mixed costs, and selling and administrative costs respectively in chapter 4.2. If the firm is minimizing cost, the MRTS is the maximum rate that firm M can exchange the use of input L for the use of input L' (in producing output h), while maintaining the same output.

$\text{MRPT}^{M}_{h,\,h'} =$ Marginal Rate of Product Transformation for firm M between outputs h and h'. If the firm is maximizing profit, the MRTP is the maximum rate that firm M can exchange the output of product h for the output of product h',, while maintaining the same cost.

U'_h $=$ Marginal Utility of Good h

H'_L $=$ Marginal Input of Good L $\forall$ $L = i,j,k$ (in all combinations of i,j,k).

G'_h $=$ Marginal Output of Good h

R_h $=$ Selling Price of good h.

w_L $=$ Cost (Price) of Input (Factor) L $\forall$ $L = i,j,k$ (in all combinations of i,j,k).

The First Fundamental Theorem of Welfare Economics (The Invisible Hand Theorem) states that under conditions of perfect competition and no externalities (i.e., all goods are traded), market equilibrium conditions are Pareto optimal. Since the definition of Pareto optimality is that no person can be made better off without making another person worse off, the policy maker wishes to maximize the utility of at least one person while holding the utilities of all other players constant.

The intuitive proof of the invisible hand theorem follows from the market equilibrium conditions and is true if the following conditions are simultaneously met:

1.   From equation A.0.2, the $\text{MRS}^{A}_{h,h'} = \dfrac{R_h}{R_{h'}}$. Likewise, $\text{MRS}^{B}_{h,h'} = \dfrac{R_h}{R_{h'}}$ since consumers A and B face the same market prices for goods. Therefore, $\text{MRS}^{A}_{h,h'} = \text{MRS}^{B}_{h,h'}$ $\forall$ consumers A and B and and outputs h. Thus consumptive efficiency is obtained.

Consumptive Efficiency $\text{MRS}^{A}_{L,\,L'} = \text{MRS}^{B}_{L,\,L'}$ $\forall$ h, h' A.0.5

2. From equation A.0.3, the $MRTS_{L,L'}^M = \dfrac{w_L}{w_{L'}}$ Likewise, the $MRTS_{L,L'}^R = \dfrac{w_L}{w_{L'}}$ since producers M and R face the same input prices.[46] Therefore, $MRTS_{L,L'}^M = MRTS_{L,L'}^R$ $\forall$ producers M and R and $\forall$ goods $L = i,j,k$. Thus productive efficiency is obtained.

Productive Efficiency $\qquad MRTS_{L,\,L'}^M = MRTS_{L,\,L'}^R \qquad \forall \quad L, L'$ $\qquad\qquad$ A.0.6

3. From equation A.0.4, the $MRPT_{h,h'}^M = \dfrac{R_h}{R_{h'}}$. Likewise, $MRPT_{h,h'}^R = \dfrac{R_h}{R_{h'}}$ since producers M and R may sell the same goods. Therefore $MRPT_{h,h'}^M = MRPT_{h,h'}^R$. $\forall$ producers A and C.

4. From equations A.0.2, A.0.4, and A.0.5, $MRS_{h,h'} = \dfrac{R_h}{R_{h'}} = MRPT_{h,h'}$ $\forall$ h, A, B, M, and R. As a result, consumers and producers efficiently allocate resources to the same goods.

Allocative Efficiency $\qquad MRS_{h,\,h'} = MRPT_{h,\,h'} \qquad \forall \quad h, h'$ $\qquad\qquad$ A.0.7

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[46] As a result, any tax policy which causes some firms to face different *effective* input cost ratios than other firms, causes inefficiency.

Appendix B.1

The model of a profit-maximizing firm subject to the input capitalization rules of §263A is developed in chapter 4.2 and is shown in equations 4.2.3 - 4.2.7. The model of the profit-maximizing firm subject to §263A [equations 4.2.3 - 4.2.7] is compared to well-known productive and allocative efficiency conditions from the economics literature to determine if §263A leads to greater or diminished allocatively and productively efficient behavior. The specific productive and allocative efficiency criterion are discussed in chapter 4.0 and appendix A and are listed in equations 4.0.1 - 4.0.3.

In appendix B.1, the profit-maximizing model is shown and first order conditions are calculated with respect to output. The method of Lagrange [Chiang, 1984, p.372-3] is used, so L is substituted for Π, and the Lagrangian multiplier (λ) is multiplied by the constraint. In appendix B.1, the allocative efficiency conditions are also examined with respect to the criteria of equation 4.0.3. In appendix B.2, the first order conditions of the profit function are calculated with respect to the three types of inputs defined in §471 and §263A and the marginal rates of technical substitution for the general case are calculated. In appendix B.3, the productive efficiency conditions between firms *within* the manufacturing, retailing, and service industries are calculated and examined with respect to the criteria of equation 4.0.2. In appendix B.4, the productive efficiency conditions *between* the manufacturing, retailing, and service industries are calculated and examined with respect to the criteria of equation 4.0.2.

The terms that will be used in appendices B.1 - B.4 are as follows:

Π	=	Firm profit
L	=	The Lagrangian representation of profit subject to the production constraint. L is substituted for Π.
t	=	The firm's tax rate $[0 < t < 1]$.
$\sum_{h=1}^{H} R_h q_h$	=	Total revenue where R_h is the selling price of the hth. good and q_h is the quantity of the hth good sold.
$\sum_{L=1}^{l} w_L x_L$	=	The variable accounting and economic costs of manufacturing (i), mixed activities (j), and selling and administration (k) when L=i,j,k respec-

tively. w is the unit price of the variable cost of interest and x is the quantity of the factor

$\sum_{L=1}^{l} F_L$ = Fixed cost of manufacturing (i), mixed activities (j), and selling and administration (k) when L = i,j,k respectively.

$\sum_{L=1}^{l} v'_L x_L$ = The effective *tax* costs of manufacturing and mixed activities after the imposition of uniform capitalization where L = i,j. v' is different from w because v' includes w and allocated fixed manufacturing costs, both discounted for the period of time held in inventory [Equations 4.2.4 and 4.2.5]. Tax law does not require that pure administration and selling costs be allocated and thus the effective and nominal wage rate equal [Equation 4.2.6].

θ_L = The proportion of manufacturing, mixed activities, and pure selling and administration cost required to be allocated to inventory when L = i, j, and k. If the cost is required to be allocated, $0<\theta_L\leq1$. Otherwise, $\theta_L = 0$. No pure selling and administrative costs are allocated and deferred, so $\theta_k = 0$.

$(1 + r)^n$ = The discounting factor (r) for the average period of time (n) inventory is retained.

$g(q_1, q_2, \ldots, q_a) = h(x_1, x_2, \ldots, x_{I+J+K})$. The firm's multi-product production function expressed as a function of outputs [g(.)] and as a function of inputs [h(.)]. This function determines the quantity of each input that must be used to produce a certain combination of outputs. For example, if only one output is produced, g(.) is that output, and h(.) describes the inputs that are used.

λ = The Lagrangian multiplier.

From equations 4.2.3 - 4.2.7:

$$L = \sum_{h=1}^{H} R_h q_h - \sum_{i=1}^{I} w_i x_i - \sum_{j=1}^{J} w_j x_j - \sum_{k=1}^{K} w_k x_k - \sum_{i=1}^{I} F_i - \sum_{j=1}^{J} F_j - \sum_{k=1}^{K} F_k$$

$$- t[\sum_{h=1}^{H} R_h q_h - \sum_{i=1}^{I} v'_i x_i - \sum_{i=1}^{I} (1 - \theta_i)w_i x_i - \sum_{j=1}^{J} v'_j x_j - \sum_{j=1}^{J} (1 - \theta_j)w_j x_j - \sum_{k=1}^{K} v'_k x_k]$$

$$- t[- \sum_{k=1}^{K} (1 - \theta_k)w_k x_k - \sum_{i=1}^{I} (1 - \theta_i)F_i - \sum_{j=1}^{J} (1 - \theta_j)F_j - \sum_{k=1}^{K} (1 - \theta_k)F_k] \qquad \text{B.1.1}$$

with the following identities,

$$v'_i x_i = \frac{\theta_i w_i x_i + \theta_i F_i}{(1 + r)^n} \qquad \text{B.1.2}$$

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$$v_j^! x_j = \frac{\theta_j w_j x_j + \theta_j F_j}{(1 + r)^n} \qquad\qquad\qquad\qquad\qquad\qquad \text{B.1.3}$$

$$v_k^! x_k = \frac{\theta_k w_k x_k + \theta_k F_k}{(1 + r)^n} = 0 \qquad\qquad \text{If } \theta_k = 0 \qquad\qquad \text{B.1.4}$$

subject to,

$$\lambda[g(q_1, q_2, \ldots, q_a) - h(x_1, x_2, \ldots, x_{I+\ J+\ K}) = 0]. \qquad\qquad \text{B.1.5}$$

By algebraic manipulation and substitution, equation B.1.2 becomes,

$$v_i^T = \left[\frac{\theta_i w_i x_i + \theta_i F_i}{x_i(1 + r)^n} \right] = \frac{[\theta_i w_i + \theta_i f_i]}{(1 + r)^n} \ \text{ where } (f_i = \frac{F_i}{x_i}). \qquad\qquad \text{B.1.6}$$

Using the same manipulations and substitutions, equation B.1.3 becomes,

$$v_j^T = \left[\frac{\theta_j w_j x_j + \theta_j F_j}{x_j(1 + r)^n} \right] = \frac{[\theta_j w_j + \theta_j f_j]}{(1 + r)^n} \ \text{ where } (f_j = \frac{F_j}{x_j}). \qquad\qquad \text{B.1.7}$$

By substituting the results of equations B.1.6 and B.1.7, equations B.1.1 and B.1.2 become,

$$L \qquad = \sum_{h=1}^{H} R_h q_h - \sum_{i=1}^{I} w_i x_i - \sum_{j=1}^{J} w_j x_j - \sum_{k=1}^{K} w_k x_k - \sum_{i=1}^{I} F_i - \sum_{j=1}^{J} F_j - \sum_{k=1}^{K} F_k$$

$$- t\left[\sum_{h=1}^{H} R_h q_h - \sum_{i=1}^{I} \frac{\theta_i(w_i + f_i)x_i}{(1 + r)^n} - \sum_{i=1}^{I} (1 - \theta_i)w_i x_i - \sum_{j=1}^{J} \frac{\theta_j(w_j + f_j)x_j}{(1 + r)^n} \right]$$

$$- t\left[- \sum_{j=1}^{J} (1 - \theta_j)w_j x_j - \sum_{k=1}^{K} w_k x_k - \sum_{i=1}^{I} (1 - \theta_i)F_i - \sum_{j=1}^{J} (1 - \theta_j)F_j - \sum_{k=1}^{K} F_k \right]$$

$$- \lambda[g(q_1, q_2, ..., q_h) - h(x_1, x_2, ..., x_{I+\ J+\ K}) = 0]. \qquad\qquad \text{B.1.8}$$

$$\frac{\partial L}{\partial q_h} \quad = (1 - t) \, R_h - \lambda \frac{\partial g(q_h)}{\partial q_h} = 0 \qquad \text{or} \quad (1 - t)R_h = \lambda g'(q_h) \qquad\qquad \text{B.1.9}$$

$$\frac{\partial L}{\partial q_{h'}} \quad = (1 - t) \, R_{h'} - \lambda \frac{\partial g(q_{h'})}{\partial q_{h'}} = 0 \qquad \text{or} \quad (1 - t)R_{h'} = \lambda g'(q_{h'}) \qquad\qquad \text{B.1.10}$$

$$MRPT_{q_h, h'} \; = \; \frac{g'(q_h)}{g'(q_{h'})} = \frac{R_h}{R_{h'}} \qquad\qquad\qquad\qquad\qquad\qquad\qquad \text{B.1.11}$$

CONCLUSIONS:

1. Equation 4.0.3 shows that the economy is allocatively efficient [i.e., producers produce un-constrained profit maximizing combinations and consumers purchase utility maximizing combinations] when:

$$\text{MRS}_{h,\,h'} = \text{MRPT}_{h,\,h'} \; = \; \frac{R_h}{R_{h'}}$$

2. Section 263A changes the tax treatment of inputs, not outputs. Because §263A does not change the taxation of outputs, there is no tax distortion to consumers, and:

$$\text{MRS}_{h,\,h'} \; = \; \frac{R_h}{R_{h'}}$$

3. While it is true that uniform capitalization has an equilibrium effect on outputs, the effect is reflected in the price of the goods and consumers make different (than before §263A), but utility-maximizing decisions under §263A.

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4. The characteristics of the code sections and the different impacts of the sections are captured in the θ_L parameter. Because this parameter is not present in equation B.1.11, neither §471 nor §263A cause tax, distortions and for all firms:

$$MRPT_{h,h'} = \frac{g'(q_h)}{g'(q_{h'})} = \frac{R_h}{R_{h'}}$$

5. As there are no tax distortion effects on consumer or producer prices, both §471 and §263A lead to allocatively efficient behavior across code sections and across firms because:

$$MRS_{h,\,h'} = MRPT_{h,\,h'} = \frac{R_h}{R_{h'}}$$

6. The intuition of this result is that inputs are treated differently by §471 and §263A, but there is no difference in the taxation of outputs. Therefore, there are no allocative distortions between firms or between firms and consumers under §471 or §263A.

Appendix B.2

The model of a profit-maximizing firm subject to the input capitalization rules of §263A was shown in appendix B.1 and allocative efficiency conditions were examined. In this appendix, the first order conditions of the same model are calculated with respect to manufacturing, mixed activities, and selling and administrative items and the marginal rates of technical substitution for each input combination are computed. At the end of the appendix, there is discussion of the different definitions of manufacturing costs under §471 and §263A and how the differences are modeled for wholesalers, retailers, and service firms.

$$\frac{\partial L}{\partial x_i} = w_i - \frac{t\theta_i[w_i + f_i]}{(1+r)^n} - t[1 - \theta_i]w_i + \lambda \frac{\partial h(q)}{\partial x_i} = 0 \qquad \text{B.2.1}$$

$$= w_i[1 - t[1 - \theta_i[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_i f_i}{[1+r]^n} + \lambda \frac{\partial h(q)}{\partial x_i} = 0 \qquad \text{B.2.2}$$

$$\frac{\partial L}{\partial x_{i'}} = w_{i'}[1 - t[1 - \theta_{i'}[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_{i'} f_{i'}}{[1+r]^n} + \lambda \frac{\partial h(q)}{\partial x_{i'}} = 0 \qquad \text{B.2.3}$$

$$\frac{\partial L}{\partial x_j} = w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_j}{[1+r]^n} + \lambda \frac{\partial h(q)}{\partial x_j} = 0 \qquad \text{B.2.4}$$

$$\frac{\partial L}{\partial x_{j'}} = w_{j'}[1 - t[1 - \theta_{j'}[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_{j'} f_{j'}}{[1+r]^n} + \lambda \frac{\partial h(q)}{\partial x_{j'}} = 0 \qquad \text{B.2.5}$$

$$\frac{\partial L}{\partial x_k} = w_k[1 - t] + \lambda \frac{\partial h(q)}{\partial x_k} = 0 \qquad \text{B.2.6}$$

$$\frac{\partial L}{\partial x_{k'}} = w_{k'}[1 - t] + \lambda \frac{\partial h(q)}{\partial x_{k'}} = 0 \qquad \text{B.2.7}$$

$$MRTS_{i,i'} \quad = \frac{h'_i}{h'_{i'}} = \frac{w_i[1 - t[1 - \theta_i[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_i f_i}{[1+r]^n}}{w_{i'}[1 - t[1 - \theta_{i'}[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_{i'} f_{i'}}{[1+r]^n}} \qquad \text{B.2.8}$$

$$MRTS_{j,j'} \quad = \frac{h'_j}{h'_{j'}} = \frac{w_j[1 - t[1 - \theta_j[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_j f_j}{[1+r]^n}}{w_{j'}[1 - t[1 - \theta_{j'}[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_{j'} f_{j'}}{[1+r]^n}} \qquad \text{B.2.9}$$

$$MRTS_{k,k'} \quad = \frac{h'_k}{h'_{k'}} = \frac{w_k[1 - t]}{w_{k'}[1 - t]} = \frac{w_k}{w_{k'}} \qquad \text{B.2.10}$$

$$MRTS_{i,j} \quad = \frac{h'_i}{h'_j} = \frac{w_i[1 - t[1 - \theta_i[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_i f_i}{[1+r]^n}}{w_j[1 - t[1 - \theta_j[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_j f_j}{[1+r]^n}} \qquad \text{B.2.11}$$

$$MRTS_{i,k} \quad = \frac{h'_i}{h'_k} = \frac{w_i[1 - t[1 - \theta_i[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_i f_i}{[1+r]^n}}{w_k[1 - t[1 - \theta_k[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_k f_k}{[1+r]^n}} \qquad \text{B.2.12}$$

$$MRTS_{j,k} \quad = \frac{h'_j}{h'_k} = \frac{w_j[1 - t[1 - \theta_j[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_j f_i}{[1+r]^n}}{w_k[1 - t[1 - \theta_k[\dfrac{[1+r]^n - 1}{[1+r]^n}]]] - \dfrac{t\theta_k f_k}{[1+r]^n}} \qquad \text{B.2.13}$$

To assess the efficiency effects of §471 costing relative to §263A, one must compare the tax cost systems independently across firms within industries and across industries. Order i such that:

1. ia = 1 to A   Those manufacturing costs that are allocated to inventory under §471 and §263A rules. Because all of these manufacturing costs are required to be allocated to inventory, $\theta_{ia} = 1$ under both §471 and §263A.

2. iu = A + 1 to U   Those manufacturing costs that are allocated to inventory under §263A, but are not required to be allocated under §471. Because all these manufacturing costs are required to be allocated under §263A, $\theta_{iu} = 1$. However, none of these manufacturing costs are required to be allocated under §471, so $\theta_{iu} = 0$.

Retail (R) and service (S) firms do not have manufacturing costs and as a result, the comparisons of manufacturing costs will only be within manufacturers (M). Therefore, $MRTS_{i,j}^{M,R,S}$, $MRTS_{i,j}^{M,R,S}$, $MRTS_{i,k}^{M,R,S}$ are comparisons that do not exist and will not be shown.

Because §471 and §263A apply uniformly to all firms in a given industry except for very small firms, one might infer that all firms are affected equally and there are no productive efficiency effects between firms in a given industry. The analyses that follow in appendices B.3 and B.4 show that this inference is not correct.

The values of equations B.2.8 - B.2.13 are computed for firms within an an industry in appendix B.3 for manufacturers, retailers, and service firms under §471 and §263A by substituting θ_L values from Exhibit 4.2. The values of equations B.2.8 - B.2.13 are computed for firms between industries in appendix B.4.

Appendix B.3.1

The model of a profit-maximizing firm subject to the input capitalization rules of §263A was shown in appendix B.1 and allocative efficiency conditions were examined. In appendix B.2, the first order conditions of the same model were calculated with respect to the three types of inputs as defined in §471 and §263A and the marginal rates of technical substitution for each input combination were computed. In appendices B.3.1 - B.3.3, the MRTS computed in appendix B.2 in general are made specific to manufacturers (B.3.1), retailers (B.3.2), and service firms (B.3.3) by inserting the values of θ shown in Exhibit 4.2 (under §471 and §263A). The MRTS for all the possible combinations of productive efficiency conditions for firms *within* the manufacturing, retailing, and service industries are computed. In appendix B.3.1, the MRTS of manufacturing firms only are compared under §471 and §263A.

Manufacturers

§471

§263A

$$MRTS_{ia,ia'} =$$

$$MRTS_{ia,ia'} =$$

B.3.1.1

$$\frac{w_{ia}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia}}{[1+r]^n}}{w_{ia'}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia'}}{[1+r]^n}}$$

$$\frac{w_{ia}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia}}{[1+r]^n}}{w_{ia'}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia'}}{[1+r]^n}}$$

$$MRTS_{iu,iu'} =$$

$$MRTS_{iu,iu'} =$$

B.3.1.2

$$\frac{w_{iu}}{w_{iu'}}$$

$$\frac{w_{iu}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{iu}}{[1+r]^n}}{w_{iu'}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{iu'}}{[1+r]^n}}$$

$$MRTS_{ia,iu} =$$

$$MRTS_{ia,iu} =$$

B.3.1.3

$$\frac{w_{ia}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia}}{[1+r]^n}}{w_{iu}[1 - t]}$$

$$\frac{w_{ia}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia}}{[1+r]^n}}{w_{iu}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{iu'}}{[1+r]^n}}$$

Manufacturers

<table>
<tr><td>§471</td><td>§263A</td></tr>
</table>

$MRTS_{j,j'} =$ $MRTS_{j,j'} =$ B.3.1.4

$$\frac{w_j}{w_{j'}}$$

$$\frac{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_j}{[1+r]^n}}{w_{j'}[1 - t[1 - \theta_{j'}[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_{j'} f_{j'}}{[1+r]^n}}$$

$MRTS_{k,k'} =$ $MRTS_{k,k'} =$ B.3.1.5

$$\frac{w_k}{w_{k'}}$$ $$\frac{w_k}{w_{k'}}$$

$MRTS_{ia,j} =$ $MRTS_{ia,j} =$ B.3.1.6

$$\frac{w_{ia}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia}}{[1+r]^n}}{w_j[1 - t]}$$

$$\frac{w_{ia}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia}}{[1+r]^n}}{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_j}{[1+r]^n}}$$

$MRTS_{iu,j} =$ $MRTS_{iu,j} =$ B.3.1.7

$$\frac{w_{iu}}{w_j}$$

$$\frac{w_{iu}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{iu}}{[1+r]^n}}{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_j}{[1+r]^n}}$$

$MRTS_{ia,k} =$ $MRTS_{ia,k} =$ B.3.1.8

$$\frac{w_{ia}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia}}{[1+r]^n}}{w_k[1 - t]}$$

$$\frac{w_{ia}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{ia}}{[1+r]^n}}{w_k[1 - t]}$$

$MRTS_{iu,k} =$ $MRTS_{iu,k} =$ B.3.1.9

$$\frac{w_{iu}}{w_k}$$

$$\frac{w_{iu}[1 - t[1 - [\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{tf_{iu}}{[1+r]^n}}{w_k[1 - t]}$$

$$MRTS_{j,k} = \qquad\qquad MRTS_{j,k} = \qquad\qquad \text{B.3.1.10}$$

$$\frac{w_j}{w_k} \qquad\qquad \frac{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_{iu}}{[1+r]^n}}{w_k[1 - t]}$$

Summary:

Sections 471 and 263A apply equally to all manufacturing firms and lead to productive efficiency [equation 4.0.2] only if $MRTS^{M1} = MRTS^{M2}$. It is not necessary that the $MRTS^{M1}$ equals any particular number (including the price ratio), but rather the $MRTS^{M1}$ must simply equal $MRTS^{M2}$. For analytic tractability, it is helpful for the $MRTS$ to equal the price ratio, so that one can be certain that all firms have an equal $MRTS$ under a particular tax act. The equal price ratio occurs because all firms pay the same price for inputs in competitive markets. It is important that the MRTS be equal for all firms in an industry because otherwise a trade of inputs could increase output levels at all affected firms.

If the $MRTS$ has numerous allocated terms [see equation B.3.1.2], the $MRTS$ do not equal for all firms under a particular tax act unless by chance all the allocated terms are equal. The allocated terms will be equal for all firms in an industry only if one makes the unlikely assumption that all firms in all markets have precisely the same production technology and use precisely the same cost allocation techniques. If all firms choose the same production technology, the firms have the same proportions of fixed and variable costs. Firms with the same production technology also keep the same inventory quantities and use the same optimal cost allocation techniques. Assuming that all firms in an industry choose the same production technology and use the same cost allocation techniques results in the allocated terms being equal across firms. If the allocated terms are equal across firms, the $MRTS^{M1} = MRTS^{M2}$. This unlikely possibility must be kept in mind when analyzing the results of appendices B.3.1 - B.4.

When examining the productive efficiency of §471 and §263A, there are five possibilities that must be examined:

1. **Section 471 leads to productively efficient behavior, while §263A leads to productively ineffi-cient behavior** [Equations B.3.1.2, B.3.1.4, B.3.1.7, B.3.1.9, B.3.1.10]. The narrow definition of manufacturing cost under §471 is expanded under §263A. The result is that none of the costs in this category are capitalized under §471, so the $MRTS_{iu,iu'}$ for all manufacturing firms equals the price ratio. This leads to productively efficient behavior under §471 since all firms in a competitive market face the same input prices. All of the costs in this category are cap-italized under §263A, so the $MRTS_{iu,iu'}$ for all manufacturing firms do not equal each other (because of the cost allocations required) and therefore productively efficient decisions are not made. Section 263A leads to productively inefficient behavior. Since §471 already leads to productively efficient behavior, §263A cannot lead to an improvement in efficiency for costs in this comparison. This same logic applies to the $MRTS_{j,j'}$, $MRTS_{iu,j}$, and $MRTS_{iu,k}$ for all manufacturing firms under sections 471 and 263A.

2. **Section 263 leads to behavior that is more productively inefficient than the behavior §471 leads to** [Equations B.3.1.3 and B.3.1.6]. Because of the cost capitalizations required under §471, the $MRTS_{ia,iu}$ for all manufacturing firms do not equal each other. This means that produc-tively efficient decisions are not made. The same logic holds for the cost capitalizations re-quired under §263A. Since both §263A and §471 lead to productively inefficient behavior, it must be determined if §263A leads to more productively inefficient behavior than §471.

    The numerators of the $MRTS_{ia,iu}$ are precisely the same under §471 and §263A. Because of the cost capitalizations required, the $MRTS_{ia,iu}$ for all manufacturing firms under §471 do not equal each other. The same logic holds for the $MRTS_{ia,iu}$ for all manufacturing firms under §263A. Therefore any inefficiencies in the numerator are precisely the same under §471 and §263A. The denominators of the $MRTS_{ia,iu}$ are not the same under §471 and §263A.

    The denominator of the $MRTS_{ia,iu}$ under §471 is simply the wage rate times one minus the tax rate. This means that all manufacturers under §471 must have the same denominator of the $MRTS_{ia,iu}$ because all firms in a competitive market face the same input costs and tax

rates. The denominator of the $MRTS_{ia,iu}$ under §263A includes many cost allocations. Therefore the denominator of the $MRTS_{ia,iu}$ is not the same for all manufacturing firms.

In summary, the numerators of the $MRTS_{ia,iu}$ for all manufacturing firms under §471 do not equal each other but are identically the same under §471 and §263A. The denominators for all manufacturing firms under §471 are identical, but the denominators for all manufacturing firms under §263A are different. Since these conditions are true, §263A cannot lead to an improvement in productive efficiency. The logic of the last four paragraphs also applies to the $MRTS_{ia,j}$.

3. **Both §471 and §263A lead to equally productive inefficient behavior** [Equations B.3.1.1, B.3.1.8]. Manufacturing costs as narrowly defined under §471 are capitalized using precisely the same rules under §471 and §263A. The result is that the $MRTS_{ia,ia'}$ of manufacturing firms 1 and 2 under §471 do not equal each other (because of the cost allocations required) and therefore productively efficient decisions are not made. The $MRTS_{ia,ia'}$ of manufacturing firms 1 and 2 under §263A, precisely equal the $MRTS_{ia,ia'}$ of manufacturing firms 1 and 2 under §471. This means that §263A has no impact on productive efficiency for these cost comparisons because §471 and §263A lead to equally inefficient behavior since they use the same rules. This same logic applies to the $MRTS_{ia,k}$ of manufacturing firms under sections 471 and 263A.

4. **Both §471 and §263A lead to productively efficient behavior** [Equation B.3.1.5]. Pure selling and administrative costs are not covered under §471 or §263A. The result is that the $MRTS_{k,k'}$ of manufacturing firms 1 and 2 under §471 each equal the price ratio. Since all firms in competitive markets face the same price for inputs, productively efficient decisions are made. The same is true of the $MRTS_{k,k'}$ of manufacturing firms 1 and 2 under §263A. Since both §471 and §263A lead to productively efficient behavior, §263A has no impact on productive efficiency for these cost comparisons.

5. **Section 263A leads to productively efficient behavior, while §471 leads to productively ineffi-cient behavior.** There are no examples of this case in this model.

Conclusions:

Using the criteria of equation 4.0.2, §263A leads to all the productive inefficiencies of §471 for manufacturers, cures none of the inefficiencies of §471, and adds inefficiency to manufacturers unless one makes the unlikely assumption that all firms in all markets have precisely the same production technology and use precisely the same cost allocation techniques. Therefore, §263A cannot lead to an improvement in efficiency for manufacturing firms and probably leads to more inefficient pro-ductive behavior than §471.

Appendix B.3.2

In appendices B.3.1 - B.3.3, the MRTS computed in appendix B.2 in general are made specific to manufacturers, retailers, and service firms by inserting the values of θ shown in Exhibit 4.2 (under §471 and §263A). The MRTS for all the possible combinations of productive efficiency conditions for firms *within* the manufacturing, retailing, and service industries are computed. In appendix B.3.1, the MRTS of manufacturing firms were compared under §471 and §263A. In appendix B.3.2, the MRTS of retailing firms are compared under §471 and §263A.

Retailers

§471   §263A

$MRTS_{j,j'} =$ $MRTS_{j,j'} =$ B.3.1.2

$\dfrac{w_j}{w_{j'}}$ $\dfrac{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_j}{[1+r]^n}}{w_{j'}[1 - t[1 - \theta_{j'}[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_{j'} f_{j'}}{[1+r]^n}}$

$MRTS_{k,k'} =$ $MRTS_{k,k'} =$ B.3.2.2

$\dfrac{w_k}{w_{k'}}$ $\dfrac{w_k}{w_{k'}}$

$MRTS_{j,k} =$ $MRTS_{j,k} =$ B.3.2.3

$\dfrac{w_j}{w_k}$ $\dfrac{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_{iu}}{[1+r]^n}}{w_k[1 - t]}$

Summary:

1.   The $MRTS_{j,j'}^{R_1}$ of retail firm 1 equals the $MRTS_{j,j'}^{R_2}$ of retail firm 2 under §471 because all firms in a competitive market face the same input prices. Because of the cost allocations required under §263A, the $MRTS_{j,j'}^{M_1} \neq MRTS_{j,j'}^{M_2}$. From equation 4.0.2, §471 leads to productively ef-

ficient behavior while §263A leads to a decrease in productively efficient behavior for costs in this comparison. The same analysis follows for $MRTS^R_{j,k}$.

2. $MRTS^R_{k,k'} = MRTS^R_{k,k'}$ for both §471 and §263A since all firms in a competitive market face the same input prices. Therefore both §471 and §263A lead to productively efficient behavior by retail firms in this comparison.

3.   There is not a case where §263A leads to productively efficient behavior while §471 leads to productively inefficient behavior.

Conclusions:

Using the criteria of equation 4.0.2, §471 leads to productively efficient behavior by retailers. Section 263A adds sources of inefficiency to retailers unless one makes the unlikely assumption that all retailing firms in all markets have precisely the same production technology and use precisely the same cost allocation techniques. Therefore, §263A cannot lead to an improvement in efficiency for retail firms and probably leads to more inefficient productive behavior than §471.

Appendix B.3.3

In appendices B.3.1 - B.3.3, the MRTS computed in appendix B.2 in general are made specific to manufacturers, retailers, and service firms by inserting the values of θ shown in Exhibit 4.2 (under §471 and §263A). The MRTS for all the possible combinations of productive efficiency conditions for firms *within* within the manufacturing, retailing, and service industries are computed. In appendices B.3.1 - B.3.2, the MRTS of manufacturing and retailing firms were compared under §471 and §263A. In appendix B.3.3, the MRTS of service firms are compared under §471 and §263A.

Service Firms

§471	§263A	
$MRTS_{j,j'} =$	$MRTS_{j,j'} =$	B.3.3.1
$\dfrac{w_j}{w_{j'}}$	$\dfrac{w_j}{w_{j'}}$	
$MRTS_{k,k'} =$	$MRTS_{k,k'} =$	B.3.3.2
$\dfrac{w_k}{w_{k'}}$	$\dfrac{w_k}{w_{k'}}$	
$MRTS_{j,k} =$	$MRTS_{j,k} =$	B.3.3.3
$\dfrac{w_j}{w_k}$	$\dfrac{w_j}{w_k}$	

Summary:

1. The $MRTS_{j,j'}^{S}$ of service firm 1 equals the $MRTS_{j,j'}^{S}$ of service firm 2 under both sections 471 and 263A. This occurs because all firms in a competitive market face the same input prices. From equation 4.0.2, sections 471 and §263A lead to productively efficient behavior. The same analysis holds for $MRTS_{k,k'}^{S}$ and $MRTS_{j,k}^{S}$.

2. The $MRTS_{jj'}^{S_1}$ of service firm 1 equals the $MRTS_{jj'}^{S_2}$ of service firm 2 under §471 because no service firms are subject to the provisions of §471. If service firms were required to meet the provisions of §263A, $MRTS_{jj'}^{S_1} \neq MRTS_{jj'}^{S_2}$. From equation 4.0.2, §471 leads to productively efficient behavior, but §263A would lead to productively inefficient behavior for service firms. Therefore, adding §263A to service firms leads to more inefficient productive behavior than §471. The same analysis follows for $MRTS_{k,k'}^{S}$ and $MRTS_{j,k}^{S}$. This means that §263A would lead to productively inefficiently behavior if service firms were included because more marginal rates of technical substitution would not be equal across service firms.

3. There are no cases where §263A leads to productively efficient behavior while §471 leads to productively inefficient behavior.

Conclusions:

Using the criteria of equation 4.0.2, both §471 and §263A lead to productively efficient behavior by service firms. Adding §263A to service firms would lead to productively inefficient behavior by service firms unless one makes the unlikely assumption that all retailing firms in all markets have precisely the same production technology and use precisely the same cost allocation techniques. Therefore, §263A cannot lead to an improvement in efficiency for service firms and probably leads to more inefficient productive behavior than §471.

Appendix B.4.1

The model of a profit-maximizing firm subject to the input capitalization rules of §263A was shown in appendix B.1 and allocative efficiency conditions were examined. In appendix B.2, the first order conditions of the same model were calculated with respect to the three types of inputs as defined in §471 and §263A and the marginal rates of technical substitution for each input combination were computed. In appendix B.3, the MRTS for all the possible combinations of productive efficiency conditions for firms *within* the manufacturing, retailing, and service industries were computed. In appendices B.4.1 - B.4.2, the MRTS computed in appendix B.2 in general are made specific to manufacturers, retailers, and service firms by inserting the values of θ shown in Exhibit 4.2 (under §471 and §263A). In appendix B.4.1, the MRTS for all the possible combinations of productive efficiency conditions under §471 *between* firms are computed for the manufacturing, retailing, and service industries. In appendix B.4.2, the MRTS for all the possible combinations of productive efficiency conditions under §263A *between* firms are computed for the manufacturing, retailing, and service industries.

§471

Manufacturers:	**Retailers:**	**Service Firms:**	
$MRTS_{j,j'} =$	$MRTS_{j,j'} =$	$MRTS_{j,j'} =$	B.4.1.1
$\dfrac{w_j}{w_{j'}}$	$\dfrac{w_j}{w_{j'}}$	$\dfrac{w_j}{w_{j'}}$	
$MRTS_{k,k'} =$	$MRTS_{k,k'} =$	$MRTS_{k,k'} =$	B.4.1.2
$\dfrac{w_k}{w_{k'}}$	$\dfrac{w_k}{w_{k'}}$	$\dfrac{w_k}{w_{k'}}$	
$MRTS_{j,k} =$	$MRTS_{j,k} =$	$MRTS_{j,k} =$	B.4.1.3
$\dfrac{w_j}{w_k}$	$\dfrac{w_j}{w_k}$	$\dfrac{w_j}{w_k}$	

Summary:

1. The $MRTS_{j,j'}^{M}$ for manufacturing firms equals the $MRTS_{j,j'}^{R}$ for retail firms equals the $MRTS_{j,j'}^{S}$ for service firms under §471 and they all equal the price ratio. From equation 4.0.2, this leads to productive efficiency because all firms in all markets face the same input prices. The same analysis holds for $MRTS_{k,k'}^{M,R,S}$ and $MRTS_{j,k}^{M,R,S}$.

Conclusions:

Using the criteria of equation 4.0.2, §471 leads to productively efficient behavior for comparisons between manufacturing, retailing, and service firms.

In appendix B.4.1, the MRTS for all the possible combinations of productive efficiency conditions under §471 *between* firms are computed for the manufacturing, retailing, and service industries. In appendix B.4.2, the MRTS for all the possible combinations of productive efficiency conditions under §263A *between* firms are computed for the manufacturing, retailing, and service industries.

§263A

Manufacturers:	**Retailers:**	**Services**	
$MRTS_{j,j'} =$	$MRTS_{j,j'} =$	$MRTS_{j,j'} =$	B.4.2.1

$$\frac{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_j}{[1+r]^n}}{w_{j'}[1 - t[1 - \theta_{j'}[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_{j'} f_{j'}}{[1+r]^n}}$$

$$\frac{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_j}{[1+r]^n}}{w_{j'}[1 - t[1 - \theta_{j'}[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_{j'} f_{j'}}{[1+r]^n}}$$

$$\frac{w_j}{w_{j'}}$$

$MRTS_{k,k'} =$	$MRTS_{k,k'} =$	$MRTS_{k,k'} =$	B.4.2.2

$$\frac{w_k}{w_{k'}}$$

$$\frac{w_k}{w_{k'}}$$

$$\frac{w_k}{w_{k'}}$$

$MRTS_{j,k} =$	$MRTS_{j,k} =$	$MRTS_{j,k} =$	B.4.2.3

$$\frac{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_{iu}}{[1+r]^n}}{w_k[1 - t]}$$

$$\frac{w_j[1 - t[1 - \theta_j[\frac{[1+r]^n - 1}{[1+r]^n}]]] - \frac{t\theta_j f_{iu}}{[1+r]^n}}{w_k[1 - t]}$$

$$\frac{w_j}{w_k}$$

Summary:

1. In general, the $MRTS_{j,j'}^M$ of a manufacturing firm does not equal the $MRTS_{j,j'}^R$ of a retailing firm does not equal the $MRTS_{j,j'}^S$ of a service firm under §263A. From equation 4.0.2, §471 leads to productively efficient behavior, while §263A leads to productively inefficient behavior. This is true because $MRTS_{j,j'}^M \neq MRTS_{j,j'}^R \neq MRTS_{j,j'}^S$ under §263A, while $MRTS_{j,j'}^M = MRTS_{j,j'}^R$

$= MRTS_{j,j'}^{S}$ under §471. The same analysis follows for $MRTS_{j,k}^{M,R,S}$ for comparisons between manufacturing, retail, and service firms.

2. Sections 471 and 263A do not apply to pure selling and administrative costs, so the $MRTS_{k,k'}^{M} = MRTS_{k,k'}^{R} = MRTS_{k,k'}^{S}$ under both §471 and §263A. From equation 4.0.2, since all firms in competitive markets face the same input prices, both §471 and §263A lead to productively efficient behavior between manufacturers, retailers, and service firms in this comparison.

3. If the §263A rules were applied to service firms, there would be no decrease in productive efficiency because firms already make productively inefficient decisions because $MRTS_{j,j'}^{M} \neq MRTS_{j,j'}^{R} \neq MRTS_{j,j'}^{S}$ under §471. Adding §263A to retailers does not solve any inefficiencies unless by sheer coincidence some of the allocation terms are equal as described in part 2 above (i.e., one makes the unlikely assumption that all firms in all markets have precisely the same production technology and use precisely the same cost allocation techniques.

4. There are no cases where §263A leads to productively efficient behavior while §471 leads to productively inefficient behavior.

5. Intuitively, one might argue that subjecting all firms to the same distortions leads to more productively efficient behavior because all firms have the same or close to the same distortions. If all the firms have the same distortions, then all the firms have the same MRTS and productive efficiency occurs. This possibility could have materialized, but retail and service firms do not have manufacturing costs. From Exhibit 4.2, if retail and service firms did not capitalize manufacturing costs under §471, but did capitalize manufacturing costs under §263A, productive efficiency between manufacturers, retailers, and service firms might have been enhanced by the required capitalizations. Because retail and service firms do not have manufacturing costs, this possibility did not develop.

Conclusions:

1. Using the criteria of equation 4.0.2, §471 leads to efficient behavior between manufacturers, retailers, and service firms. Section 263A adds sources of inefficiency to the comparisons between manufacturers, wholesalers, and service firms unless one makes the unlikely assumption that all firms in all markets have precisely the same production technology and use precisely the same cost allocation techniques. Assuming that production technology is identical across industries is particularly difficult because of the inherent differences between industries. Therefore, §263A cannot lead to an improvement in efficiency for manufacturing firms and probably leads to more inefficient productive behavior than §471. Requiring service firms to be covered by the rules of §263A creates no further inefficiencies, and only solves any of the productive efficiencies if by sheer coincidence some of the allocation terms are equal (i.e., one makes the unlikely assumption that all firms in all markets have precisely the same production technology and use precisely the same cost allocation techniques.)

The model of a profit-maximizing firm subject to the uniform capitalization rules of §263A is developed in chapter 5.1 and is shown in equation 5.2.1. The model is analyzed in Appendices C.1 - C.5 to determine if production in period one, production in period two, and inventory holding between periods one and two increase or decrease. Three specific things are done in Appendix C.1. First, the first order conditions of the profit function are calculated with respect to the choice variables of production in period one, production in period two, and inventory holding between the two periods. Second, the matrix of second order conditions [Chiang 1984, p.212] is set up to compute the changes in production and inventory holding when §263A is imposed. Third, Cramer's rule is used to determine whether production in the first period increases or decreases because of §263A.

Appendices C.2 - C.3 determine whether production in the second period and inventory holding between the two periods increase or decrease because of §263A. All the second order conditions under the general assumptions of the model, partial equilibrium, and LIFO inventory are calculated in Appendix C.4. The results from the various assumptions in Appendix C.4 are briefly summarized in Appendix C.5. The results from Appendix C.5 are inserted into Appendices C.1 - C.3 as required.

The terms that are used in appendices C.1 - C.5 are:

Π	=	Firm profit
P_i	=	The price of the good in period i $[P_i > 0]$.
q_i	=	The quantity of the good produced and sold in period i $[q_i > 0]$.
$c_i(q_i)$	=	The firm's production cost in period i which is a function of quantity produced in that period $[c_i(q_i)$ and $\partial c_i(q_i)/\partial q_i > 0]$. $c_i(q_i)$ will not equal $c_{i+1}(q_{i+1})$ unless $q_i = q_{i+1}$. Production cost includes all costs to acquire the good and get it to the ultimate consumer, including manufacturing, marketing, and selling and administrative items.
t_i	=	The tax rate in period i $[0 < t_i < 1]$. t_i may or may not equal t_{i+1}.
r	=	The discount rate $[0 \leq r \leq 1]$.
I_i	=	Units of inventory held at the end of period i $[I_i \geq 0]$.

I_{0-k} = Beginning inventory in units that comes from an implicit prior period. The 0-k subscript indicates what period the inventory units came from. If the firm is a FIFO taxpayer, k equals zero. This indicates that the ending year 0 inventory came from year 0 production. If the firm is a LIFO taxpayer, k equals some number greater than zero. This indicates that the ending year 0 inventory came from production in periods prior to year 0.

$h_i(I_i)$ = Economic inventory holding cost [$h_i(I_i)$ and $\dfrac{\partial h_i(I_i)}{\partial I_i} \geq 0$].

$H(.)$ = Total holding cost including pure economic holding cost and the tax deferral costs of holding inventory from §471 and §263A.

Θ_1 = The proportion of the firm's *production* (including manufacturing, selling and administrative) costs that must be allocated to inventory under §471 and/or §263A [$0 \leq \Theta_1 \leq 1$]. Θ_1 strictly increased when §263A was added to the previously existing §471 [Seago, 1987].

Θ_2 = The proportion of the firm's *holding* costs that must be allocated to inventory under §471 and/or §263A [$0 \leq \Theta_2 \leq 1$]. Θ_2 strictly increased when §263A was added to the previously existing §471 [Seago, 1987].

δ_j = The increase in the proportion of production (1) and holding (2) costs that must be allocated to inventory (j = 1,2) respectively because of §263A [$0 \leq \delta_j$].

$\Theta_1[\dfrac{I_{0-k}}{q_{0-k}}]c_{0-k}(q_{0-k})$ = Production costs in inventory from some prior period (0-k), a portion of which must be added to taxable income. If the firm is a FIFO taxpayer, k equals zero. This indicates that the ending year 0 inventory came from year 0 production. If the firm is a LIFO taxpayer, k equals some number greater than zero. This indicates that the ending year 0 inventory came from production in periods prior to year 0.

$\Theta_2[\dfrac{I_{0-k}}{q_{0-k}}]h_{0-k}(I_{0-k})$ = Inventory holding costs from some prior period (0-k), a portion of which must be added to taxable income.

ρ = The proportion of inventory from current period production. ρ is close to 1 under the FIFO assumption and close to 0 under the LIFO assumption [$0 \leq \rho \leq 1$].

$1 - \rho$ = The proportion of inventory from prior period production. ($1 - \rho$) is close to 0 under the FIFO assumption and close to 1 under to LIFO assumption.

From 5.2.1, the firm's profit maximizing objective is:

$$\Pi = P_1[1 - t_1][q_1 + I_{0-k} - I] + [\frac{1}{1+r}]P_2[1 - t_2][q_2 + I] -$$

$$c_1(q_1, I_{0-k}, I, \Theta_j)[1 - t_1] - \left[\frac{1}{1+r}\right]c_2(q_2, I, \Theta_j)[1 - t_2] -$$

$$\delta_1\Theta_1\left[\frac{I_{0-k}t_p}{q_{0-k}}\right]c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) - \delta_2\Theta_2\left[\frac{I_{0-k}t_p}{q_{0-k}}\right]h_{0-k}(I_{0-k}) -$$

$$H(I_{0-k}, I, q_{0-k}, q_i, \Theta_j, t_1, r, \rho) \qquad\qquad \text{C.1.1}$$

Where:

$$H(I_{o-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho) =$$

$$h_1(I, \Theta_j)[1 - t_1] + \frac{I\rho}{q_1}\left[t_1 - \frac{t_2}{1+r}\right][\Theta_j c_1(q_1, I_{0-k}, I, \Theta_j) + \Theta_j h_1(I, \Theta_j)] -$$

$$\frac{I_{0-k}\rho}{q_{0-k}}\left[\rho t_1 + \frac{t_2[1-\rho]}{1+r}\right][\Theta_j c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) + \Theta_j h_{0-k}(I_{0-k})] \qquad \text{C.1.2}$$

Because the firm wishes to jointly maximize profit with respect to quantities produced and inventory levels maintained, the following first order conditions must be simultaneously met:

$$F_1 = \frac{\partial\Pi}{\partial q_1} = P_1[1 - t_1] - \frac{\partial c_1(q_1, I_{0-k}, I, \Theta_j)}{\partial q_1}[1 - t_1] - \frac{\partial H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial q_1} = 0$$

$$\text{C.1.3}$$

$$F_2 = \frac{\partial\Pi}{\partial q_2} = P_2\frac{[1 - t_2]}{[1 + r]} - \frac{\partial c_2(q_2, I, \Theta_j)}{\partial q_2}\frac{[1 - t_2]}{[1 + r]} = 0$$

$$\text{C.1.4}$$

$$F_3 = \frac{\partial\Pi}{\partial I} = -P_1[1 - t_1] + P_2\frac{[1 - t_2]}{[1 + r]} - \frac{\partial c_1(q_1, I_{0-k}, I, \Theta_j)}{\partial I}[1 - t_1]$$

$$- \frac{\partial c_2(q_2, I, \Theta_j)}{\partial I} \frac{[1 - t_2]}{[1 + r]} - \frac{\partial H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_1, r, \rho)}{\partial I} = 0$$

<div align="right">C.1.5</div>

To determine whether quantities produced and inventory carrying levels increase or decrease with respect to changes in the amount of cost allocated to inventory, the system of first order conditions (Equations C.1.3 - C.1.5) must be fully differentiated and the parameters other than the quantities produced, inventory level, allocation rates are assumed to be constant [i.e., the derivatives of the functions with respect to $I_{0-k}, q_{0-k}, r, t_i, P_i, \rho = 0$]. That system of equations yields the following matrix [Chiang 1984, p 212].

$$\begin{bmatrix} \dfrac{\partial F_1}{\partial q_1} & \dfrac{\partial F_1}{\partial q_2} & \dfrac{\partial F_1}{\partial I} \\[2ex] \dfrac{\partial F_2}{\partial q_1} & \dfrac{\partial F_2}{\partial q_2} & \dfrac{\partial F_2}{\partial I} \\[2ex] \dfrac{\partial F_3}{\partial q_1} & \dfrac{\partial F_3}{\partial q_2} & \dfrac{\partial F_3}{\partial I} \end{bmatrix} \begin{bmatrix} \dfrac{\partial q_1}{\partial \Theta_j} \\[2ex] \dfrac{\partial q_2}{\partial \Theta_j} \\[2ex] \dfrac{\partial I}{\partial \Theta_j} \end{bmatrix} = \begin{bmatrix} -\dfrac{\partial F_1}{\partial \Theta_j} \\[2ex] -\dfrac{\partial F_2}{\partial \Theta_j} \\[2ex] -\dfrac{\partial F_3}{\partial \Theta_j} \end{bmatrix}$$

<div align="right">C.1.6</div>

The matrix is solved for $\dfrac{\partial q_1}{\partial \Theta_j}, \dfrac{\partial q_2}{\partial \Theta_j}, \dfrac{\partial I}{\partial \Theta_j}$ and the results indicate an increase or a decrease in the quantities under consideration when the allocation rate is changed. Using Cramer's rule for solving the matrix [Chiang, 1984, p. 107-10] and inserting zero values as computed in Appendix C.5:

$$\frac{\partial q_1}{\partial \Theta_j} = \frac{\begin{bmatrix} -\dfrac{\partial F_1}{\partial \Theta_j} & 0 & \dfrac{\partial F_1}{\partial I} \\[12pt] -\dfrac{\partial F_2}{\partial \Theta_j} & \dfrac{\partial F_2}{\partial q_2} & 0 \\[12pt] -\dfrac{\partial F_3}{\partial \Theta_j} & 0 & \dfrac{\partial F_3}{\partial I} \end{bmatrix}}{\begin{bmatrix} \dfrac{\partial F_1}{\partial q_1} & 0 & \dfrac{\partial F_1}{\partial I} \\[12pt] 0 & \dfrac{\partial F_2}{\partial q_2} & 0 \\[12pt] \dfrac{\partial F_3}{\partial q_1} & 0 & \dfrac{\partial F_3}{\partial I} \end{bmatrix}} \qquad\qquad C.1.7$$

Which yields:[47]

$$\frac{\partial q_1}{\partial \Theta_j} = \frac{[\dfrac{\partial F_2}{\partial q_2}][\{-\dfrac{\partial F_1}{\partial \Theta_j}\}\{\dfrac{\partial F_3}{\partial I}\} - \{\dfrac{\partial F_1}{\partial I}\}\{-\dfrac{\partial F_3}{\partial \Theta_j}\}]}{[\dfrac{\partial F_2}{\partial q_2}][\{\dfrac{\partial F_1}{\partial q_1}\}\{\dfrac{\partial F_3}{\partial I}\} - \{\dfrac{\partial F_1}{\partial I}\}\{\dfrac{\partial F_3}{\partial q_1}\}]} \qquad\qquad C.1.8$$

The denominator of C.1.8 is negative because it is the third principal minor of the Jacobian matrix. Because the first term in the numerator is negative as a result of the second principal minor and the denominator is negative because of the third principal minor, the sign of the second term in the numerator determines the sign of the derivative. Therefore:

$$\frac{\partial q_1}{\partial \Theta_j} \leq 0$$

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[47] The firm is a profit maximizer and therefore the first and third principal minors of the Jacobian matrix of second order conditions are negative. The denominator of C.1.8 is the Jacobian matrix of second order conditions. The second principal minor is The second principal minor is positive [Chiang, 1984, p. 336]. Since $\dfrac{\partial F_1}{\partial q_1}$ is negative and the second principal minor is positive, $\dfrac{\partial F_2}{\partial q_2}$ is negative. Likewise, since $\dfrac{\partial F_1}{\partial q_1}$ and $\dfrac{\partial F_2}{\partial q_2}$ are negative, $\dfrac{\partial F_3}{\partial I}$ must also be negative.

Iff:

$$\left[\left\{-\frac{\partial F_1}{\partial \Theta_j}\right\}\left\{\frac{\partial F_3}{\partial I}\right\} - \left\{\frac{\partial F_1}{\partial I}\right\}\left\{-\frac{\partial F_3}{\partial \Theta_j}\right\}\right] \leq 0 \qquad\qquad\text{C.1.9}$$

The value taken on by equation C.1.9 depends upon the economic and legal assumptions made. This research incorporates three sets of unrelated assumptions that result in six possible outcomes. The effect of §263A being efficient vs. §263A being inefficient is modeled. The general case where no equilibrium assumption is made vs. the equilibrium assumption is modeled.[48] The equilibrium assumption also requires the simplified method (i.e., $\Theta = \Theta_j$) for mathematical tractability. The effects of LIFO inventory for tax purposes (with no equilibrium assumption) are modeled. The positive (+), negative (-), zero (-0-), or ambiguous (?) values shown in Appendix C.5 are inserted into C.1.9 as follows:

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[48] Equilibrium occurs in the long run when there are zero economic profits to attract entrants into the market. See equation C.4.14.

| Assumption | §263A Is Efficient | §263A Is Inefficient |

The market is not necessarily in equilibrium. [There are no equilibrium, Θ, LIFO, or inventory accumulation assumptions.]

$$[\,?\,][\,-\,] - [\,?\,][\,?\,] = ? \qquad\qquad [\,?\,][\,-\,] - [\,?\,][\,?\,] = ?$$

The market is in equilibrium and $\Theta_1 = \Theta_2$. [There are no LIFO or inventory accumulation assumptions.]

$$[\,?\,][\,-\,] - [\,?\,][\,?\,] = ? \qquad\qquad [\,?\,][\,-\,] - [\,?\,][\,?\,] = ?$$

LIFO inventory is used for tax purposes and no inventory is accumulated. [There are no equilibrium or Θ assumptions.]

$$[\,-\,][\,-\,] - [\,0\,][\,?\,] = + \qquad\qquad [\,+\,][\,-\,] - [\,-0\,][\,?\,] = -$$

Conclusions:

1. The general conclusion that can be reached is that if LIFO is used for tax purposes and no current period production is in inventory, production in the first period unambiguously increases if §263A is efficient and unambiguously decreases if §263A is inefficient. The intuition of this result is that if LIFO is assumed and no current period production is retained in inventory, all current period production and holding costs are charged to expense. If §263A allows productively efficient behavior, costs decrease, and production increases. If §263A allows productively inefficient behavior, costs increase, and production decreases.

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2. The results depend upon whether §263A allows productively efficient or inefficient behavior. If §263A has no efficiency effects on firms, no change in output behavior occurs. Appendices B.3 - B.4 show that §263A unambiguously causes productively inefficient behavior.

3. If LIFO inventory and no current period production in inventory are assumed, the results are not necessarily reversed, they are just intractable in this model of general cost functions. The assumption of no current period production simply allows mathematical tractability.

4. The §481 adjustment is modeled as δ in equation 5.1.7. This parameter does not appear in the first order conditions of C.1.3 - C.1.5 and C.4.41 - C.4.43. Therefore, the §481 adjustment has no impact on future production and inventory holding decisions. This demonstrates that the §481 lump-sum adjustment is truly efficient because it does not distort future decisions.

5. Because the §481 adjustment has no impact on future production and inventory holding decisions, the LIFO or FIFO choice can have no impact on the §481 adjustment.

Appendix C.2

The model of a profit-maximizing firm subject to the uniform capitalization rules of §263A was shown in appendix C.1 and the conditions under which production in the first period increases or decreases because of §263A were determined. In appendix C.2, the output model [equations C.1.1 - C.1.5] is analyzed to determine if production in period two increases or decreases. Using Cramer's rule [and inserting zero values as computed in Appendix C.5] to solve the matrix of second order conditions [equation C.1.6] for $\dfrac{\partial q_2}{\partial \Theta_j}$ yields:

$$\frac{\partial q_2}{\partial \Theta_j} = \frac{\begin{bmatrix} \dfrac{\partial F_1}{\partial q_1} & -\dfrac{\partial F_1}{\partial \Theta_j} & \dfrac{\partial F_1}{\partial I} \\[2mm] 0 & -\dfrac{\partial F_2}{\partial \Theta_j} & 0 \\[2mm] \dfrac{\partial F_3}{\partial q_1} & -\dfrac{\partial F_3}{\partial \Theta_j} & \dfrac{\partial F_3}{\partial I} \end{bmatrix}}{\begin{bmatrix} \dfrac{\partial F_1}{\partial q_1} & 0 & \dfrac{\partial F_1}{\partial I} \\[2mm] 0 & \dfrac{\partial F_2}{\partial q_2} & 0 \\[2mm] \dfrac{\partial F_3}{\partial q_1} & 0 & \dfrac{\partial F_3}{\partial I} \end{bmatrix}} \qquad\qquad \text{C.2.1}$$

Which yields:

$$\frac{\partial q_2}{\partial \Theta_j} = \frac{[-\dfrac{\partial F_2}{\partial \Theta_j}][\{\dfrac{\partial F_1}{\partial q_1}\}\{\dfrac{\partial F_3}{\partial I}\} - \{\dfrac{\partial F_1}{\partial I}\}\{\dfrac{\partial F_3}{\partial q_1}\}]}{[\dfrac{\partial F_2}{\partial q_2}][\{\dfrac{\partial F_1}{\partial q_1}\}\{\dfrac{\partial F_3}{\partial I}\} - \{\dfrac{\partial F_1}{\partial I}\}\{\dfrac{\partial F_3}{\partial q_1}\}]} = \frac{-\dfrac{\partial F_2}{\partial \Theta_j}}{\dfrac{\partial F_2}{\partial q_2}} \qquad\qquad \text{C.2.2}$$

$\dfrac{\partial F_2}{\partial q_2}$ is negative as a result of the second principal minor.[49] The value that $-\dfrac{\partial F_2}{\partial \Theta_j}$ takes on

depends upon the economic and legal assumptions made. This research incorporates three sets of

unrelated assumptions that result in six possible outcomes. The effect of §263A being efficient vs.

§263A being inefficient is modeled. The general case where no equilibrium assumption is made vs.

the equilibrium assumption is modeled. The equilibrium assumption also requires the simplified

method (i.e., $\Theta = \Theta_j$) for mathematical tractability. The effects of LIFO inventory for tax purposes

(with no equilibrium assumption) are modeled. The positive (+), negative (-), zero (-0-), or am-

biguous (?) values shown in Appendix C.5 are inserted into C.2.2 as follows:

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[49] The firm is a profit maximizer and therefore the first and third principal minors of the Jacobian matrix of second order conditions are negative. The denominator of C.2.1 is the Jacobian matrix of second order conditions. The second principal minor is positive [Chiang, 1984, p. 336]. Since $\dfrac{\partial F_1}{\partial q_1}$ is negative and the second principal minor is positive, $\dfrac{\partial F_2}{\partial q_2}$ is negative. Likewise, since $\dfrac{\partial F_1}{\partial q_1}$ and $\dfrac{\partial F_2}{\partial q_2}$ are negative, $\dfrac{\partial F_3}{\partial I}$ must also be negative.

Assumption	§263A Is Efficient	§263A Is Inefficient

The market is not necessarily in equilibrium. [There are no equilibrium, Θ, LIFO, or inventory accumulation assumptions.]

$$-/- \ = \ +$$

$$+/- \ = \ -$$

The market is in equilibrium and $\Theta_1 = \Theta_2$. [There are no LIFO or inventory accumulation assumptions.]

$$-/- \ = \ +$$

$$+/- \ = \ -$$

LIFO inventory is used for tax purposes and no inventory is accumulated. [There are no equilibrium or Θ assumptions.]

$$-/- \ = \ +$$

$$+/- \ = \ -$$

Conclusions:

1. The general conclusion that can be reached is that production in the second period unambiguously increases if §263A is efficient and unambiguously decreases if §263A is inefficient independent of the equilibrium or LIFO assumption made. All past and current period production and holding costs are charged to expense in the last period because there is no

ending inventory. If §263A is efficient, costs decrease, and production increases. If §263A is inefficient, costs increase, and production decreases.

2. The results depend upon whether §263A allows productively efficient or inefficient behavior. If §263A has no efficiency effects on firms, no change in output behavior occurs. Appendices B.3 - B.4 that §263A unambiguously causes productively inefficient behavior.

Appendix C.3

The model of a profit-maximizing firm subject to the uniform capitalization rules of §263A was shown in appendices C.1 - C.2 and the conditions under which production in the first period and second period increase or decrease were determined. The output model [equations C.1.1 - C.1.5] is analyzed in Appendix C.3 to determine if inventory holding increases or decreases. Using Cramer's rule [and inserting zero values as computed in Appendix C.5] to solve the matrix of second order conditions [equation C.1.6] for $\dfrac{\partial I}{\partial \Theta_j}$ yields:

$$\frac{\partial I}{\partial \Theta_j} = \frac{\begin{bmatrix} \dfrac{\partial F_1}{\partial q_1} & 0 & -\dfrac{\partial F_1}{\partial \Theta_j} \\[2ex] 0 & \dfrac{\partial F_2}{\partial q_2} & -\dfrac{\partial F_2}{\partial \Theta_j} \\[2ex] \dfrac{\partial F_3}{\partial q_1} & 0 & -\dfrac{\partial F_3}{\partial \Theta_j} \end{bmatrix}}{\begin{bmatrix} \dfrac{\partial F_1}{\partial q_1} & 0 & \dfrac{\partial F_1}{\partial I} \\[2ex] 0 & \dfrac{\partial F_2}{\partial q_2} & 0 \\[2ex] \dfrac{\partial F_3}{\partial q_1} & 0 & \dfrac{\partial F_3}{\partial I} \end{bmatrix}}$$

C.3.1

Which yields:

$$\frac{\partial I}{\partial \Theta_j} = \frac{[\dfrac{\partial F_2}{\partial q_2}][\{\dfrac{\partial F_1}{\partial q_1}\}\{-\dfrac{\partial F_3}{\partial \Theta_j}\} - \{-\dfrac{\partial F_1}{\partial \Theta_j}\}\{\dfrac{\partial F_3}{\partial q_1}\}]}{[\dfrac{\partial F_2}{\partial q_2}][\{\dfrac{\partial F_1}{\partial q_1}\}\{\dfrac{\partial F_3}{\partial I}\} - \{\dfrac{\partial F_1}{\partial I}\}\{\dfrac{\partial F_3}{\partial q_1}\}]}$$

C.3.2

The denominator of C.3.2 is negative because it is the third principal minor of the Jacobian matrix. Because the first term in the numerator is negative as a result of the second principal minor

and the denominator is negative because of the third principal minor, the sign of the second term in the numerator determines the sign of the derivative. Therefore:

$$\frac{\partial I}{\partial \Theta_j} \leq 0$$

Iff:

$$[\{\frac{\partial F_1}{\partial q_1}\}\{-\frac{\partial F_3}{\partial \Theta_j}\} - \{-\frac{\partial F_1}{\partial \Theta_j}\}\{\frac{\partial F_3}{\partial q_1}\}] \leq 0 \qquad\qquad\qquad C.3.3$$

The value that C.3.3 takes on depends upon the economic and legal assumptions made. This research incorporates three sets of unrelated assumptions that result in six possible outcomes. The effect of §263A being efficient vs. §263A being inefficient is modeled. The general case where no equilibrium assumption is made vs. the equilibrium assumption is modeled. The equilibrium assumption also requires the simplified method (i.e., $\Theta = \Theta_j$) for mathematical tractability. The effects of LIFO inventory for tax purposes (with no equilibrium assumption) are modeled. The positive (+), negative (-), zero (-0-), or ambiguous (?) values shown in Appendix C.5 are inserted into C.3.3 as follows:

| Assumption | §263A Is Efficient | §263A Is Inefficient |

The market is not necessarily in equilibrium. [There are no equilibrium, Θ, LIFO, or inventory accumulation assumptions.]

$$[\, - \,][\, ? \,] - [\, ? \,][\, ? \,] = ? \qquad\qquad [\, - \,][\, ? \,] - [\, ? \,][\, ? \,] = ?$$

The market is in equilibrium and $\Theta_1 = \Theta_2$. [There are no LIFO or inventory accumulation assumptions.]

$$[\, - \,][\, ? \,] - [\, ? \,][\, ? \,] = ? \qquad\qquad [\, - \,][\, ? \,] - [\, ? \,][\, ? \,] = ?$$

LIFO inventory is used for tax purposes and no inventory is accumulated. [There are no equilibrium or Θ assumptions.]

$$[\, - \,][\, ? \,] - [\, - \,][\, -0 \,] = ? \qquad\qquad [\, - \,][\, ? \,] - [\, + \,][\, -0 \,] = ?$$

Conclusions:

1. Under the LIFO method, since $\dfrac{\partial F_1}{\partial q_1} < 0$, C.3.3 is negative if $-\dfrac{\partial F_3}{\partial \Theta_j} > 0$. From C.4.39, $-\dfrac{\partial F_3}{\partial \Theta_j} > 0$ if:

$$\frac{\partial^2 c_1(.)}{\partial I \partial \Theta_j} [1 - t_1] + \frac{\partial^2 c_2(.)}{\partial I \partial \Theta_j} \frac{[1 - t_2]}{[1 + r]} + \frac{\partial^2 h(.)}{\partial I \partial \Theta_j} [1 - t_1] > 0 \qquad\qquad \text{C.3.4}$$

Using the LIFO inventory method for tax purposes [i.e., ending inventory comes from the earliest available production, primarily beginning inventory] and assuming the results of

equation C.3.4 [i.e., inventory stays the same or decreases] is equivalent to assuming that ρ = 0 [the proportion of ending inventory from current production is zero]. In developing equation 5.1.9, it was argued that selling and administrative costs avoided one period because of producing, but not selling inventory are incurred the next period. Therefore $c_1(I)$ should approximately equal $c_2(I)$. Likewise, it seems reasonable to believe that $\dfrac{\partial c_1(.)}{\partial I}$ should approximately equal $\dfrac{\partial c_2(.)}{\partial I}$ and $\dfrac{\partial c_1^2(.)}{\partial I \partial \Theta_j}$ should approximately equal $\dfrac{\partial c_2^2(.)}{\partial I \partial \Theta_j}$. If the above case holds in reality and §263A is inefficient, then the first two terms of C.4.39 approximately cancel each other and $\dfrac{\partial h^2(.)}{\partial I \partial \Theta_j} > 0$. Appendix B proves that 263A is inefficient, so this is the relevant case. The assumption that ρ = 0 is not violated since §263A is inefficient and inventory likely decreases.

2. The intuitive conclusion that can be reached from equation C.3.3 and C.4.38 - C.4.39A is that because §263A is inefficient, LIFO is used for tax purposes, and there is no current period production cost in inventory [i.e., ρ = 0], inventory holding decreases if marginal production cost [with respect to inventory] avoided in period one increases more because of §263A than the sum of the increases in marginal holding cost [with respect to inventory] and marginal period two production cost [with respect to inventory]. This is consistent with the intuition developed in Chapter 1.1.2 where the direction of increase or decrease in inventory is determined by the relationships of production and holding cost. The mathematical results simply describe the relationship more precisely.

Appendix C.4

The model of a profit-maximizing firm subject to the uniform capitalization rules of §263A was shown in appendices C.1 - C.3 and the conditions under which production production in the first period, production in the second period, and inventory holding between the periods increase or decrease because of §263A. The derivatives that are need to solve the equations in appendices C.1 - C.3 are computed in Appendix C.4. When an equation has an unambiguous positive, negative, or zero value, the next equation is addressed. If the value of the equation is ambiguous, equation C.4.14 (equilibrium) is inserted into the result to determine if equilibrium conditions make the result unambiguous. If the value is still ambiguous, $\rho = 0$ (LIFO and no inventory accumulation) is inserted into the equation prior to the equilibrium condition to determine if the result is unambiguous.

This dissertation makes the reasonable assumption that average and marginal costs are positive and increasing. Therefore:

$$\frac{c_i(q_i, I_{0-k}, I, \Theta_j)}{q_i} > 0 \qquad\qquad\qquad \text{C.4.1}$$

$$\frac{\partial c_i(q_i, I_{0-k}, I, \Theta_j)}{\partial q_i} > 0 \qquad\qquad\qquad \text{C.4.2}$$

$$\frac{\partial c_i(q_i, I_{0-k}, I, \Theta_j)}{\partial I_i} < 0^{50} \qquad\qquad\qquad \text{C.4.3}$$

$$\frac{\partial^2 c_i(q_i, I_{0-k}, I, \Theta_j)}{\partial q_i^2} > 0 \qquad\qquad\qquad \text{C.4.4}$$

$$\frac{\partial^2 c_i(q_i, I_{0-k}, I, \Theta_j)}{\partial I_i^2} < 0 \qquad\qquad\qquad \text{C.4.5}$$

$$\frac{\partial h(I)}{\partial I} > 0 \qquad\qquad\qquad \text{C.4.6}$$

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[50] At equation 5.1.9, it is pointed out that the negative sign in front of $c_i(I_i)$ means that $\dfrac{\partial c_i(q_i, I_{0-k}, I_i)}{\partial I_i} = -\dfrac{\partial c_i(I_i)}{\partial I_i} < 0.$

$$\frac{\partial^2 h(I)}{\partial I^2} > 0,$$
<div align="right">C.4.7</div>

If §263A is efficient, total and marginal production and holding costs decrease with respect to increases in Θ_j. If §263A is inefficient, total and marginal production and holding costs increase with respect to increases in Θ_j.

§263A is Efficient: §263A is Inefficient:

$$\frac{\partial c_i(q_i, I_{0-k}, I, \Theta_j)}{\partial \Theta_j} < 0 \qquad\qquad \frac{\partial c_i(q_i, I_{0-k}, I, \Theta_j)}{\partial \Theta_j} > 0 \qquad\text{C.4.8}$$

$$\frac{\partial^2 c_i(q_i, I_{0-k}, I, \Theta_j)}{\partial q_i \partial \Theta_j} < 0 \qquad\qquad \frac{\partial^2 c_i(q_i, I_{0-k}, I, \Theta_j)}{\partial q_i \partial \Theta_j} > 0 \qquad\text{C.4.9}$$

$$\frac{\partial^2 c_1(q_i, I_{0-k}, I, \Theta_j)}{\partial I_i \partial \Theta_j} > 0 \qquad\qquad \frac{\partial^2 c_1(q_i, I_{0-k}, I, \Theta_j)}{\partial I_i \partial \Theta_j} < 0^{51} \qquad\text{C.4.10}$$

$$\frac{\partial^2 c_2(q_i, I_{0-k}, I, \Theta_j)}{\partial I_i \partial \Theta_j} < 0 \qquad\qquad \frac{\partial^2 c_2(q_i, I_{0-k}, I, \Theta_j)}{\partial I_i \partial \Theta_j} > 0 \qquad\text{C.4.11}$$

$$\frac{\partial h(I, \Theta_j)}{\partial \Theta_j} < 0 \qquad\qquad \frac{\partial h(I, \Theta_j)}{\partial \Theta_j} > 0 \qquad\text{C.4.12}$$

$$\frac{\partial^2 h(I, \Theta_j)}{\partial I \partial \Theta_j} < 0, \qquad\qquad \frac{\partial^2 h(I, \Theta_j)}{\partial I \partial \Theta_j} > 0, \qquad\text{C.4.13}$$

Firms are attracted into competitive markets by the opportunity to earn economic profits and will continue to enter the market until price is bid down to average cost, leaving no profits to be earned. Once in the market firms continue to produce until price equals marginal cost. At equilibrium:

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[51] At equation 5.1.9, it was pointed out that the negative sign in front of $c_i(I_i)$ means that $\dfrac{\partial c_i(q_i, I_{0-k}, I_i)}{\partial I_i} = -\dfrac{\partial c_i(I_i)}{\partial I_i} < 0$. When §263A is inefficient this same relationship implies that $\dfrac{\partial c_i^2(q_i, I_{0-k}, I_i)}{\partial I_i \partial \Theta_j} = -\dfrac{\partial c_i^2(I_i)}{\partial I_i \partial \Theta_j} < 0$. when §263A is inefficient.

$$\frac{\partial c_i(q_i, I_{0-k}, I, \Theta_j)}{\partial q_i} - \frac{c_i(q_i, I_{0-k}, I, \Theta_j)}{q_i} - \frac{h(I, \Theta_j)}{q_i} = 0 \qquad \text{C.4.14}$$

Because production and selling costs are separable in equation 5.1.9:

$$\frac{\partial c_i^2(q_i, I_{0-k}, I, \Theta_j)}{\partial q_i \partial I} = 0 \qquad \text{C.4.15}$$

The required second order conditions from equation C.1.6 are as follows. The references following the equations explain why the sign is positive or negative.

$$\frac{\partial F_1}{\partial q_1} = \frac{\partial^2 \Pi}{\partial q_1^2} = -\frac{\partial^2 c_1(q_1, I_{0-k}, I, \Theta_j)}{\partial q_1^2}[1 - t_1] - \frac{\partial^2 H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial q_1^2} < 0$$
$$\text{C.4.16}$$

Equation C.4.16 is negative because the first principal minor of the Jacobian is negative.

$$\frac{\partial F_1}{\partial q_2} = \frac{\partial^2 \Pi}{\partial q_1 \partial q_2} = 0 \qquad \text{C.4.17}$$

$$\frac{\partial F_1}{\partial I} = \frac{\partial^2 \Pi}{\partial q_1 \partial I} = -\frac{\partial^2 H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial q_1 \partial I} \qquad \text{C.4.18}$$

See equations C.4.15 and C.4.43

The signs of equations C.4.18 and C.4.43 are indeterminate. At equilibrium, if the firm uses the simplified method discussed in chapter 2.1 (i.e., $\Theta_1 = \Theta_2$), equation C.4.14 shows that $\frac{\partial c_i(.)}{\partial q_i} - \frac{c_i(.)}{q_i} - \frac{h(.)}{q_i} = 0$. At equilibrium, equation C.4.18 becomes:

$$\frac{\partial F_1}{\partial I} = \frac{\partial^2 \Pi}{\partial q_1 \partial I} = -\frac{\partial^2 H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial q_1 \partial I} \qquad \text{C.4.19}$$

See equation C.4.44

The signs of equations C.4.19 and C.4.44 are indeterminate. If the firm uses LIFO for tax purposes and retains no current period production in inventory, $\rho = 0$. Using the LIFO assumption, equation C.4.18 becomes:

$$\frac{\partial F_1}{\partial I} = \frac{\partial^2 \Pi}{\partial q_1 \partial I} = -\frac{\partial^2 H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial q_1 \partial I} = 0 \qquad \text{C.4.20}$$

See equation C.4.45

$$\frac{\partial F_2}{\partial q_1} = \frac{\partial^2 \Pi}{\partial q_2 \partial q_1} = 0 \qquad \text{C.4.21}$$

$$\frac{\partial F_2}{\partial q_2} = \frac{\partial^2 \Pi}{\partial q_2^2} = -\frac{\partial^2 c_2(q_2, I, \Theta_j)}{\partial q_2^2} \frac{[1 - t_2]}{[1 + r]} < 0 \qquad \text{C.4.22}$$

See equation C.4.4

$$\frac{\partial F_2}{\partial I} = \frac{\partial^2 \Pi}{\partial q_2 \partial I} = 0 \qquad \text{C.4.23}$$

See equation C.4.15

$$\frac{\partial F_3}{\partial q_1} = \frac{\partial^2 \Pi}{\partial I \partial q_1}{}^{52} = -\frac{\partial^2 H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial q_1 \partial I} \qquad \text{C.4.24}$$

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[52] $\frac{\partial^2 \Pi}{\partial I \partial q_1} = \frac{\partial^2 \Pi}{\partial q_1 \partial I}$ by Young's theorem [Chiang, 1984, p. 313].

See equations C.4.15 and C.4.43

The signs of equations C.4.24 and C.4.43 are indeterminate. At equilibrium, if the firm uses the simplified method discussed in chapter 2.1 (i.e., $\Theta_1 = \Theta_2$), equation C.4.14 shows that $\dfrac{\partial c_i(.)}{\partial q_i} - \dfrac{c_i(.)}{q_i} - \dfrac{h(.)}{q_i} = 0$. At equilibrium, equation C.4.24 becomes:

$$\frac{\partial F_3}{\partial q_1} = \frac{\partial^2 \Pi}{\partial I \partial q_1} = -\frac{\partial^2 H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial q_1 \partial I} \qquad \text{C.4.25}$$

See equation C.4.44

The signs of equations C.4.25 and C.4.44 are indeterminate. If the firm uses LIFO for tax purposes and retains no current period production in inventory, $\rho = 0$. Using the LIFO assumption, equation C.4.24 becomes:

$$\frac{\partial F_3}{\partial q_1} = \frac{\partial^2 \Pi}{\partial I \partial q_1} = -\frac{\partial^2 H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial q_1 \partial I} = 0 \qquad \text{C.4.26}$$

See equation C.4.45

$$\frac{\partial F_3}{\partial q_2} = \frac{\partial^2 \Pi}{\partial I \partial q_2} = 0 \qquad \text{C.4.27}$$

See equation C.4.15

$$\frac{\partial F_3}{\partial I} = \frac{\partial^2 \Pi}{\partial I^2} = -\frac{\partial^2 c_1(q_1, I_{0-k}, I, \Theta_j)}{\partial I^2}[1 - t_1] - \frac{\partial^2 c_2(q_2, I, \Theta_j)}{\partial I^2}\frac{[1 - t_2]}{[1 + r]} -$$

$$\frac{\partial^2 H(I_{0-k}, I_1, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial I^2} < 0 \qquad \text{C.4.28}$$

Equation C.4.28 is negative because the third principal minor of the Jacobian is negative.

$$-\frac{\partial F_1}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial q_1 \partial \Theta_j} = \frac{\partial^2 c_1(q_1, I_{0-k}, I, \Theta_j)}{\partial q_1 \partial \Theta_j}[1 - t_1] + \frac{\partial^2 H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial q_1 \partial \Theta_j} \qquad \text{C.4.29}$$

By substitution from equation C.4.46, C.4.29 becomes:

$$-\frac{\partial F_1}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial q_1 \partial \Theta_j} = \frac{\partial^2 c_1(.)}{\partial q_1 \partial \Theta_j}[1 - t_1[1 - \frac{I\rho\Theta_1}{q_1}] - \frac{I\rho\Theta_1 t_2}{q_1[1+r]}] +$$

$$\frac{I\rho}{q_1}[t_1 - \frac{t_2}{1+r}][\frac{\partial c_1(.)}{\partial q_1} - \frac{c_1(.)}{q_1} - \frac{h(.)}{q_1} - \frac{\Theta_1 \partial c_1(.)}{q_1 \partial \Theta_j} - \frac{\Theta_2 \partial h(.)}{q_1 \partial \Theta_j}] \qquad \text{C.4.30}$$

The sign of equation C.4.30 is indeterminate. At equilibrium, equation C.4.14 shows that $\frac{\partial c_i(.)}{\partial q_i} - \frac{c_i(.)}{q_i} - \frac{h(.)}{q_i} = 0$. If the firm uses the simplified method discussed in chapter 2.1 (i.e., $\Theta_1 = \Theta_2$), equation C.4.30 becomes:

$$-\frac{\partial F_1}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial q_1 \partial \Theta_j} = \frac{\partial^2 c_1(.)}{\partial q_1 \partial \Theta_j}[1 - t_1[1 - \frac{I\rho\Theta_j}{q_i}] - \frac{\Theta_j I\rho t_2}{q_1[1+r]}] -$$

$$\frac{\Theta_j I\rho}{q_1^2}[t_1 - \frac{t_2}{1+r}][\frac{\partial c_1(.)}{\partial \Theta_j} + \frac{\partial h(.)}{\partial \Theta_j}] \qquad \text{C.4.31}$$

The sign of equation C.4.31 is indeterminate. If the firm uses LIFO for tax purposes and retains no current period production in inventory, $\rho = 0$. If §263A is efficient and LIFO is assumed, equation C.4.30 becomes:

$$-\frac{\partial F_1}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial q_1 \partial \Theta_j} = \frac{\partial^2 c_1(.)}{\partial q_1 \partial \Theta_j}[1 - t_1] < 0 \qquad \text{C.4.32}$$

See equation C.4.9

If the firm uses LIFO for tax purposes and retains no current period production in inventory, $\rho = 0$. If §263A is inefficient and LIFO is assumed, equation C.4.30 becomes:

$$-\frac{\partial F_1}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial q_1 \partial \Theta_j} = \frac{\partial^2 c_1(.)}{\partial q_1 \partial \Theta_j} [1 - t_1] > 0 \qquad\qquad \text{C.4.33}$$

See equation C.4.9

If §263A is efficient:

$$-\frac{\partial F_2}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial q_2 \partial \Theta_j} = \frac{\partial^2 c_2(.)}{\partial q_2 \partial \Theta_j} \frac{[1 - t_1]}{[1 + r]} < 0 \qquad\qquad \text{C.4.34}$$

See equation C.4.9

If §263A is inefficient:

$$-\frac{\partial F_2}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial q_2 \partial \Theta_j} = \frac{\partial^2 c_2(.)}{\partial q_2 \partial \Theta_j} \frac{[1 - t_1]}{[1 + r]} > 0 \qquad\qquad \text{C.4.35}$$

See equation C.4.9

$$-\frac{\partial F_3}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial I \partial \Theta_j} = \frac{\partial^2 c_1(.)}{\partial I \partial \Theta_j} [1 - t_1] + \frac{\partial^2 c_2(.)}{\partial I \partial \Theta_j} \frac{[1 - t_2]}{[1 + r]} +$$

$$\frac{\partial^2 H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)}{\partial I \partial \Theta_j} \qquad\qquad \text{C.4.36}$$

The sign of equation C.4.36 is indeterminate. By substitution from equation C.4.49, C.4.36 becomes:

$$-\frac{\partial F_3}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial I \partial \Theta_j} = \frac{\partial^2 c_1(.)}{\partial I \partial \Theta_j} [1 - t_1[1 - \frac{\Theta_j I \rho}{q_1}] - \frac{\Theta_j I \rho}{q_1} \frac{t_2}{1 + r}] +$$

$$\frac{\partial^2 c_2(.)}{\partial I \partial \Theta_j} \frac{[1 - t_2]}{[1 + r]} + \frac{\partial^2 h(.)}{\partial I \partial \Theta_j} [1 - t_1] +$$

$$\frac{\rho}{q_1}\left[t_1 - \frac{t_2}{1+r}\right]\left[I\left[\frac{c_1(.)}{I} + \frac{\partial c_1(.)}{\partial I} + \frac{h(.)}{I} + \frac{\partial h(.)}{\partial I}\right] + \right.$$

$$\left. \Theta_j\left[\frac{\partial c_1(.)}{\partial \Theta_j} + \frac{\partial h(.)}{\partial \Theta_j} + I\frac{\partial^2 h(.)}{\partial I\partial \Theta_j}\right]\right] \qquad\qquad\text{C.4.37}$$

The sign of equation C.4.37 is indeterminate and equilibrium has no effect on the sign. If the firm uses LIFO for tax purposes and retains no current period production in inventory, $\rho = 0$ and equation C.4.37 becomes:

$$-\frac{\partial F_3}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial I\partial \Theta_j} = \frac{\partial^2 c_1(.)}{\partial I\partial \Theta_j}[1 - t_1] + \frac{\partial^2 c_2(.)}{\partial I\partial \Theta_j}\frac{[1 - t_2]}{[1 + r]} + \frac{\partial^2 h(.)}{\partial I\partial \Theta_j}[1 - t_1] \qquad\qquad\text{C.4.38}$$

See equations C.4.10, C.4.11, C.4.13.

Equation C.4.38 shows that $-\dfrac{\partial F_3}{\partial \Theta_j} > 0$ if:

$$\frac{\partial^2 c_1(.)}{\partial I\partial \Theta_j}[1 - t_1] + \frac{\partial^2 c_2(.)}{\partial I\partial \Theta_j}\frac{[1 - t_2]}{[1 + r]} + \frac{\partial^2 h(.)}{\partial I\partial \Theta_j}[1 - t_1] > 0 \qquad\qquad\text{C.4.39}$$

See equations C.4.10, C.4.11, C.4.13.

In developing equation 5.1.9, it was argued that selling and administrative costs avoided one period because of producing, but not selling, inventory are incurred the next period. Therefore $c_1(I)$ should approximately equal $c_2(I)$. Likewise, it seems reasonable to believe that $\dfrac{\partial c_1(.)}{\partial I}$ should approximately equal $\dfrac{\partial c_2(.)}{\partial I}$ and $\dfrac{\partial c_1^2(.)}{\partial I\partial \Theta_j}$ should approximately equal $\dfrac{\partial c_2^2(.)}{\partial I\partial \Theta_j}$. If the above case holds in reality and §263A is inefficient, then the first two terms of C.4.39 approximately cancel each other and $\dfrac{\partial h^2(.)}{\partial I\partial \Theta_j} > 0$. Appendix B proves §263A is inefficient, so this is the relevant case. If §263A is efficient, the first two terms of C.4.39 approximately cancel each other, and $\dfrac{\partial h^2(.)}{\partial I\partial \Theta_j} < 0$, then the equation is not possible and is not considered. Using the LIFO inventory method for tax purposes [i.e., ending inventory comes from the earliest available production, primarily beginning inventory],

and assuming the results of equation C.4.39 [i.e., inventory stays the same or decreases] is equivalent to assuming that $\rho = 0$ [the proportion of ending inventory from current production is zero].

Equation C.4.38 shows that $-\dfrac{\partial F_3}{\partial \Theta_j} < 0$ if:

$$\frac{\partial^2 c_1(.)}{\partial I \partial \Theta_j}[1 - t_1] + \frac{\partial^2 c_2(.)}{\partial I \partial \Theta_j}\frac{[1 - t_2]}{[1 + r]} + \frac{\partial^2 h(.)}{\partial I \partial \Theta_j}[1 - t_1] < 0 \qquad \text{C.4.39A}$$

See equations C.4.10, C.4.11, C.4.13.

If the above case holds in reality and §263A is efficient, then the first two terms of equation C.4.39 approximately cancel each other and $\dfrac{\partial h^2(.)}{\partial I \partial \Theta_j} < 0$. Appendix B proved that §263A is inefficient, so this case does not apply. If §263A is inefficient, the first two terms of C.4.39 approximately cancel each other, and $\dfrac{\partial h^2(.)}{\partial I \partial \Theta_j} > 0$, then the equation is not possible and is not considered.

To complete the analysis of the problem, the following derivatives of $H(I_{0-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho)$ must be computed:

$$H(I_{o-k}, I, q_{0-k}, q_1, \Theta_j, t_i, r, \rho) =$$

$$h_1(I, \Theta_j)[1 - t_1] + \frac{I\dot{\rho}}{q_1}[t_1 - \frac{t_2}{1 + r}][\Theta_j c_1(q_1, I_{0-k}, I, \Theta_j) + \Theta_j h_1(I, \Theta_j)] -$$

$$\frac{I_{0-k}\rho}{q_{0-k}}[\rho t_1 + \frac{t_2[1 - \rho]}{1 + r}][\Theta_j c_{0-k}(q_{0-k}, I_{0-k-1}, I_{0-k}) + \Theta_j h_{0-k}(I_{0-k})] \qquad \text{C.4.40}$$

$$\frac{\partial H(.)}{\partial q_1} = \frac{I\rho}{q_1}[t_1 - \frac{t_2}{1 + r}][\frac{\Theta_1 \partial c_1(.)}{\partial q_1} - \frac{\Theta_1 c_1(.)}{q_1} - \frac{\Theta_2 h(.)}{q_1}] \qquad \text{C.4.41}$$

$$\frac{\partial H(.)}{\partial I} = \frac{\partial h(.)}{\partial I}[1 - t_1] + \frac{\rho}{q_1}[t_1 - \frac{t_2}{1 + r}][\Theta_1[c_1(.) + \frac{I\partial c_1(.)}{\partial I}] + \Theta_2[h(.) + \frac{I\partial h(.)}{\partial I}]] \qquad \text{C.4.42}$$

$$\frac{\partial^2 H(.)}{\partial q_1 \partial I} = \frac{\rho}{q_1} [t_1 - \frac{t_2}{1+r}][\frac{\Theta_1 \partial c_1(.)}{\partial q_1} - \frac{\Theta_1 c_1(.)}{q_1} - \frac{\Theta_2 h(.)}{q_1} - \frac{I}{q_1}[\frac{\Theta_1 \partial c_1(.)}{\partial I} + \frac{\Theta_2 \partial h(.)}{\partial I}]]$$

$$\text{C.4.43}$$

The sign of equation C.4.43 is indeterminate. At equilibrium, if the firm uses the simplified method discussed in chapter 2.1 (i.e., $\Theta_1 = \Theta_2$), equation C.4.43 becomes:

$$\frac{\partial^2 H(.)}{\partial q_1 \partial I} = -\frac{I\rho\Theta_j}{q_1^2}[t_1 - \frac{t_2}{1+r}][\frac{\partial c_1(.)}{\partial I} + \frac{\partial h(.)}{\partial I}]$$

$$\text{C.4.44}$$

The sign of equation C.4.44 is indeterminate from equations C.4.3 and C.4.6. If the firm uses LIFO for tax purposes and retains no current period production in inventory, $\rho = 0$. Using the LIFO assumption, equation C.4.43 becomes:

$$\frac{\partial^2 H(.)}{\partial q_1 \partial I} = 0$$

$$\text{C.4.45}$$

$$\frac{\partial^2 H(.)}{\partial q_1 \partial \Theta_j} = \frac{I\rho}{q_1}[t_1 - \frac{t_2}{1+r}][\frac{\partial c_1(.)}{\partial q_1} - \frac{c_1(.)}{q_1} - \frac{h(.)}{q_1} + \frac{\Theta_1 \partial^2 c_1(.)}{\partial q_1 \partial \Theta_1} - \frac{\Theta_1}{q_1}\frac{\partial c_1(.)}{\partial \Theta_1} - \frac{\Theta_2}{q_1}\frac{\partial h(.)}{\partial \Theta_j}]$$

$$\text{C.4.46}$$

The sign of equation C.4.46 is indeterminate. At equilibrium, if the firm uses the simplified method discussed in chapter 2.1 (i.e., $\Theta_1 = \Theta_2$), equation C.4.46 becomes:

$$\frac{\partial^2 H(.)}{\partial q_1 \partial \Theta_j} = \frac{I\rho\Theta_j}{q_1}[t_1 - \frac{t_2}{1+r}][\frac{\partial^2 c_1(.)}{\partial q_1 \partial \Theta_1} - \frac{\partial c_1(.)}{q_1 \partial \Theta_1} - \frac{\partial h(.)}{q_1 \partial \Theta_j}]$$

$$\text{C.4.47}$$

At equilibrium, the sign is indeterminate. If the firm uses LIFO for tax purposes and retains no current period production in inventory, $\rho = 0$. Using the LIFO assumption, equation C.4.46 becomes:

$$\frac{\partial^2 H(.)}{\partial q_1 \partial \Theta_j} = 0$$

$$\text{C.4.48}$$

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$$\frac{\partial^2 H(.)}{\partial I \partial \Theta_j} = \frac{\partial^2 h(.)}{\partial I \partial \Theta_j} [1 - t_1] + \frac{\rho}{q_1} [t_1 - \frac{t_2}{1+r}][I[\frac{c_1(.)}{I} + \frac{\partial c_1(.)}{\partial I} + \frac{h(.)}{I} + \frac{\partial h(.)}{\partial I}] +$$

$$\Theta_j[\frac{\partial c_1(.)}{\partial \Theta_j} + I\frac{\partial^2 c_1(.)}{\partial I \partial \Theta_j} + \frac{\partial h(.)}{\partial \Theta_j} + I\frac{\partial^2 h(.)}{\partial I \partial \Theta_j}]] \qquad \text{C.4.49}$$

The sign of equation C.4.49 is indeterminate. If the firm uses LIFO for tax purposes and retains no current period production in inventory, $\rho = 0$. If §263A is efficient, equation C.4.49 becomes:

$$\frac{\partial^2 H(.)}{\partial I \partial \Theta_j} = \frac{\partial^2 h(.)}{\partial I \partial \Theta_j} [1 - t_1] < 0 \qquad \text{C.4.50}$$

See equation C.4.13

If the firm uses LIFO for tax purposes and retains no current period production in inventory, $\rho = 0$. If §263A is inefficient, equation C.4.49 becomes:

$$\frac{\partial^2 H(.)}{\partial I \partial \Theta_j} = \frac{\partial^2 h(.)}{\partial I \partial \Theta_j} [1 - t_1] > 0 \qquad \text{C.4.51}$$

See equation C.4.13

Appendix C.5

The model of a profit-maximizing firm subject to the uniform capitalization rules of §263A was shown in appendices C.1 - C.3 and the conditions under which production production in the first period, production in the second period, and inventory holding between the periods increase or decrease because of §263A. The derivative that are need to solve the equations in appendices C.1 - C.3 were computed in Appendix C.4. Appendix C.5 summarizes the signs of derivatives computed in Appendix C.4.

	General Case	Equilibrium And $\Theta_1 = \Theta_2$	LIFO And No. Additional Inventory
$\dfrac{\partial F_1}{\partial q_1} = \dfrac{\partial^2 \Pi}{\partial q_1^2}$	-	-	-
$\dfrac{\partial F_1}{\partial q_2} = \dfrac{\partial^2 \Pi}{\partial q_1 \partial q_2}$	-0-	-0-	-0-
$\dfrac{\partial F_1}{\partial I} = \dfrac{\partial^2 \Pi}{\partial q_1 \partial I}$	?	?	-0-
$\dfrac{\partial F_2}{\partial q_1} = \dfrac{\partial^2 \Pi}{\partial q_2 \partial q_1}$	-0-	-0-	-0-
$\dfrac{\partial F_2}{\partial q_2} = \dfrac{\partial^2 \Pi}{\partial q_2^2}$	-	-	-
$\dfrac{\partial F_2}{\partial I} = \dfrac{\partial^2 \Pi}{\partial q_2 \partial I}$	-0-	-0-	-0-
$\dfrac{\partial F_3}{\partial q_1} = \dfrac{\partial^2 \Pi}{\partial I \partial q_1}$	?	?	-0-
$\dfrac{\partial F_3}{\partial q_2} = \dfrac{\partial^2 \Pi}{\partial I \partial q_2}$	-0-	-0-	-0-
$\dfrac{\partial F_3}{\partial I} = \dfrac{\partial^2 \Pi}{\partial I^2}$	-	-	-

$$-\frac{\partial F_1}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial q_1 \partial \Theta_j} \qquad\qquad ? \qquad\qquad\qquad ? \qquad\qquad\qquad -/+$$

$$-\frac{\partial F_2}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial q_2 \partial \Theta_j} \qquad\qquad -/+ \qquad\qquad\qquad -/+ \qquad\qquad\qquad -/+$$

$$-\frac{\partial F_3}{\partial \Theta_j} = -\frac{\partial^2 \Pi}{\partial I \partial \Theta_j} \qquad\qquad ? \qquad\qquad\qquad ? \qquad\qquad\qquad ?$$

Where:

-0-	The derivative is unambiguously zero.
?	The sign of the derivative in ambiguous.
-	The sign of the derivative is unambiguously negative.
+	The sign of the derivative in unambiguously positive.
-/+	The sign of the derivative is unambiguously negative if §263A is efficient and is unambiguously positive if §263A is inefficient.
+/-	The sign of the derivative is unambiguously positive if §263A is efficient and is unambiguously negative if §263A is inefficient.

Table 1[53]

Indirect Costs of §263A and §471

Type of Costs	.Section 471 Regulations	Section 263A Regulations
Pure Production Cost (Category 1)		
(1) Repairs of production facilities and equipment	1	1
(2) Maintenance of facilities and equipment	1	1
(3) Utilities	1	1
(4) Rent of equipment and facilities	1	1
(5) Rent of land	2	1
(6) Indirect labor (including fringes)	1	1
(7) Indirect materials and supplies	1	1
(8) Small tools and equipment	1	1
(9) Quality control and inspection	3	1
(10) Taxes attributable to labor, materials, facilities, and equipment	3	1
(11) Depreciation-straight line	1	1
(12) Depreciation-excess	3	1
(13) Depletion-cost	1	1
(14) Depletion-excess of cost	3	1
(15) Administrative costs directly attributable to production	3	1

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[53] Taken from Seago [1987].

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(16)	Compensation to officers for services attributable to production	3	1
(17)	Insurance on facilities and equipment	3	1
(18)	Insurance on inventory	2	1
(19)	Contributions to pension,profit-sharing plans, and other employee fringes-current cost, past services cost	2	2
(20)	Research and experimental expenses (section 174)	2	2
(21)	Rework, labor, scrap, and spoilage	2	1
(22)	Bidding expenses,successful	2	1
(23)	Engineering and design	2	1
(24)	Materials handing and warehousing	2	1

Mixed Services Cost (Category 3)

(25)	Administration and coordination of production	2	1
(26)	Personnel operations	2	1
(27)	Purchasing operations	2	1
(28)	Storing and handling finished goods	2	1
(29)	Accounting and data services	2	1
(30)	Data processing	2	1
(31)	Security services	2	1
(32)	Legal department	2	1

Pure Selling and Administration Cost (Category 2)

(33)	Marketing,selling, and distribution	2	2
(34)	Bidding expenses-unsuccessful	2	2
(35)	Interest	2	2

(36)	Research and development not applicable to production	2	2
(37)	Losses under section 165	2	2
(38)	Depreciation on equipment and facilities that are temporarily idle	2	2
(39)	Income taxes	2	2
(40)	Pension and profit sharing-past services	2	2
(41)	Costs attributable to strikers	2	2
(42)	Overall management (directors, officers, and their staffs)	2	2
(43)	General business planning	2	2
(44)	Financial reporting and internal audits	2	2
(45)	Financial planning and economic forecasting	2	2
(46)	Shareholder, public and industrial relations	2	2
(47)	Tax department	2	2

Where:

1. = Cost required to be charged to inventory.

2. = Cost charged to expense in the current period.

3. = Cost charged to inventory or expense in conformity with the firm's accounting procedures.

Vita

J. Kent Poff
115 Bruton Circle
Greenville, North Carolina 27858

(919) 830-1637 (Home)
(919) 757-6161 (Office)

TEACHING AND RESEARCH INTERESTS:

(1) Teach Managerial and Tax

(2) Research Interests:
    (a) Economic and empirical analysis of Uniform Capitalization as it relates to input efficiencies, compliance costs, and tax payments.
    (b) Theoretical analysis of income and price elasticities of charitable contributions.
    (c) Akerloff Lemons-Type Analysis of the Market for Audits
    (d) Tax law issues
    (e) Application of economic analysis to Theology

EDUCATION:

Virginia Polytechnic Institute and State University (1991) - Ph.D. in Accounting (Minors in Economics and Statistics).

The Ohio State University (1984 - 1987) - Courses in Accounting Research, Economics, and Statistics.

West Virginia College of Graduate Studies (1979) - Master of Business Administration.

West Virginia Institute of Technology (1975) - Bachelor of Science in Accounting.

EMPLOYMENT HISTORY:

East Carolina University Assistant Professor (1987 - Present). Teach Tax and Managerial Accounting.

Virginia Polytechnic Institute and State University (1987 - 1990). Teach Principles of Accounting.

The Ohio State University (1984 - 1987). Taught Principles of Accounting at the Columbus and Newark campuses, Intermediate Accounting, a short course in Accounting for incoming MBA's, and the Financial and Managerial Mega Section lectures periodically.

Bluefield State College - Assistant Professor (1979 - 1984). Taught the basic accounting curriculum on a regular basis including Principles of Accounting, Intermediate Accounting, Advanced Accounting, auditing, Cost, and Tax.

J. Kent Poff - Certified Public Accountant (1979 - 1984). A wide variety of banking, professional, industrial, and construction clients were served in MAS, tax, and write-up work.

West Virginia State Treasury - Director of Fiscal Analysis (1978 - 1979). Primary duties were in issuing general obligation road and school bonds, establishing an accounting system for pooled investment funds, and monitoring cash balances for state disbursement accounts.

West Virginia College of Graduate Studies - Assistant Director of Financial Affairs (1976 -1979). Assisted the Director in all areas of College financial management including budget control, grant accounting, cash control, and liaison with faculty and government officials. Managerial models were developed to analyze capital acquisitions.

Blue Cross Hospital Services - Cost Report Analyst (1975 - 1976). Hospital financial reports were analyzed to determine if Medicare costs reported were reasonable.

PROFESSIONAL CERTIFICATION, AWARDS, AND HONORS:

(1) West Virginia CPA Certificate dated May, 1978.
(2) Coopers & Lybrand Summer Fellowship for teaching excellence (1985 & 1986).
(3) Graduated Magna Cum Laude in Accounting from West Virginia Tech.
(4) Graduated second in a class of 201 from Collins High School in Oak Hill, WV. Served as Treasurer of the Student Body and President of the Student Body, Sophomore Class, and National Honor Society.

PERSONAL:

BIRTH DATE:	December 3, 1953
HEIGHT:	5' 7"
WEIGHT:	150
MARITAL STATUS:	Married Karen A. Poff on May 31, 1975 and have four children, Sara Anne (11/20/81), Jonathan Wesley (6/13/85), Kathryn Lynn (3/16/89) and Kristina Marie (3/16/89).

REFERENCES:

Professor J. Larry Hagler (East Carolina)	(919) 757-6055
Professor W. E. Seago (Virginia Tech)	(703) 231-6564
Professor Fred M. Richardson (Virginia Tech)	(703) 231-7745
Professor Catherine C. Eckel (Virginia Tech - Economics)	(703) 231-7697
Professor Richard Steinberg (Virginia Tech - Economics)	(703) 231-5942
Professor Thomas J. Burns (Ohio State)	(614) 292-6098
Professor Daniel L. Jensen (Ohio State)	(614) 292-2529

Professor Richard S. Webster (Ohio State - Teaching)   (614) 292-5834

PARTIAL LIST OF COURSES TAKEN:

    (1)   Interdisciplinary, Financial, Managerial, Auditing, and Behavioral Research Seminars.

    (2)   Tax Research, Corporate (2), and Partnership Tax.

    (3)   Price Theory, Microeconomic Theory (Calculus), Macroeconomic Theory (Calculus), Mathematical Economics, Advanced Microeconomic Theory, Theory of Public Economics, Econometrics, Industrial Organization, Anti-Trust Economics, and The Law and Economics.

    (4)   Math Statistics (2), Non-parametric Statistics, Multivariate Statistics, Regression, Sample Survey Methods, and Experimental Design.